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NEW YORK METEOROLOGICAL OBSERVATORY REPORT.

We have just reived the report for 1878. It contains a synopsis of the wk done for the past ten years at the Observatory, Centl Park, New York City, and also descriptions of the se-recording instruments by the Director, Daniel Draper. Wth his permission we present to our readers the descripons and drawings of these instruments in the following ver. (1.) Barometer. (2.) Sun Thermometer (3.) Dry an Wet Thermometers. (4.) Direction of Wind. (5.) Velocy of Wind. (6.) Force of Wind. (7.) Rain-Gauge. We vill add that Professor Draper presents these remarkable intruments for the free use of the public. Any one who desis may, therefore, construct them.

I.—DRAPER'S BAROMETER, PENCIL, SELF-RECORDING, MERCURIAL.

I was led to consruct this form of barometer from the fact that with the photographic one it cannot be told what the atmospheric fluctuions are until the next morning, when the photographic plate is developed. Even then, if there has been much variatin in temperature, it alters the sensitiveness of the collodin film, so that it is very difficult to read the tracing. The construction of the pencil instrument is as follows:

In the pencil barometer the glass tube is 36 inches in length, the upper portion being of larger diameter than the lower; it is held firmly in a fixed position, and filled in the usual manner with quicksilver; its lower or open end dips into a tube or reservoir containing the same metal. This reservoir is suspended on two spiral steel springs, and has freedom of motion up and down. When the pressure of the atmosphere diminishes, a portion of the mercury flows out of the tube into the reservoir; this becoming heavier, stretches the steel springs, causing the ink pencil fastened to them to mark downwards. If the pressure increases the reverse movement takes place. The ink pencil makes its mark on a ruled paper register, carried at the rate of half an inch per hour from right to left by a clock.

There is a third steel spring of the same length and strength as those on the reservoir, stretched by a weight to a distance equivalent to 30 inches on the barometer scale. The object of this spring is to give the correction of temperature for those sustaining the reservoir. The register paper should always be set to the same line on which the pencil of this spring marks.

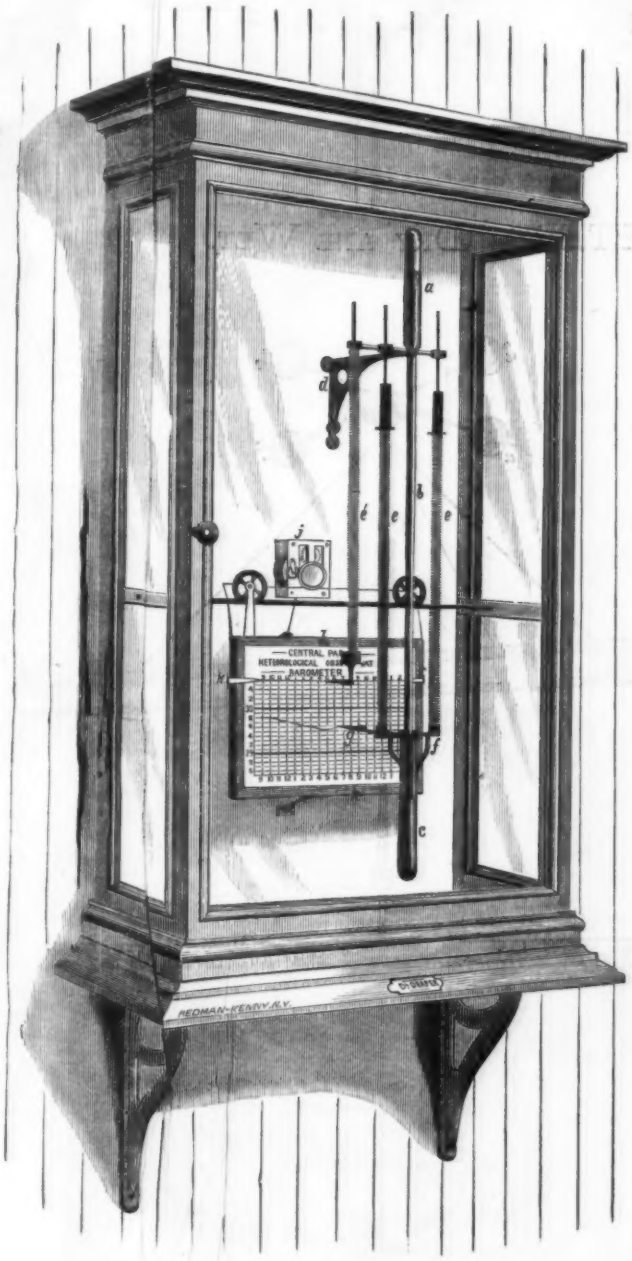
The movements of the mercury on the register can be magnified to any required extent by increasing the length of the spiral springs. In this instrument it is multiplying twice.

DESCRIPTION OF INSTRUMENT—PLATE I.

The tube marked *a b* is of glass; the upper part is of a larger diameter than the stem, *a* being ½ of an inch internal diameter and 10 inches long, while the stem, *b*, is 1/5 of an inch bore and 26 inches long. The total length of the tube is therefore 36 inches. The reservoir, *c*, is suspended from a brass frame, *d*, fastened to the back of the case. This frame also holds the upper ends of the steel springs, *e*, *e*, *ē*. The glass reservoir, *c*, is of the same diameter and length as the upper part of the tube, *a;* on its open end is turned a flange to hold it in a brass frame, *f*, to which are fastened the lower ends of the steel springs, *e e;* it also carries an ink pencil, *g*, that touches the ruled paper on the board, *h h*, which is drawn aside by the clock, *i*. The spring, *ē*, is for the correction of temperature on the other springs, as will be described below.

The most difficult part in the construction of this barometer is the filling of the tube. It may be accomplished in one of two ways, viz., either by boiling the distilled mercury in the tube, or by heating the tube and mercury, then filling the tube by a paper funnel with a very small hole with the hot mercury. When full place the finger over the open end of the tube, and invert it into a vessel containing mercury, remove the finger, and the mercury will subside in the tube, then replace the finger firmly, and incline the tube so that the vacuum bubble may gather up any air bubbles that may have become entrapped in filling; when the air is removed the open end of the tube may be turned upwards, the finger removed, and the tube filled full

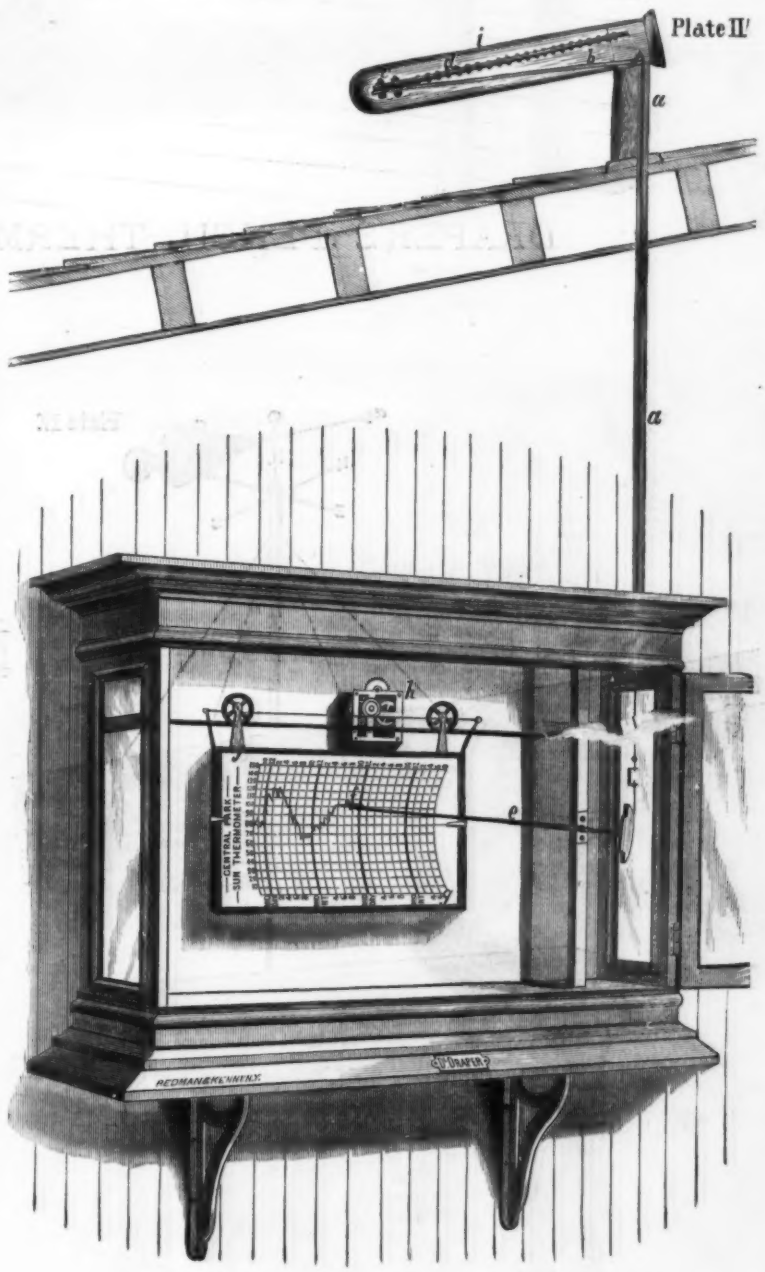
Plate I



DRAPER'S SELF-RECORDING

MERCURIAL BAROMETER.

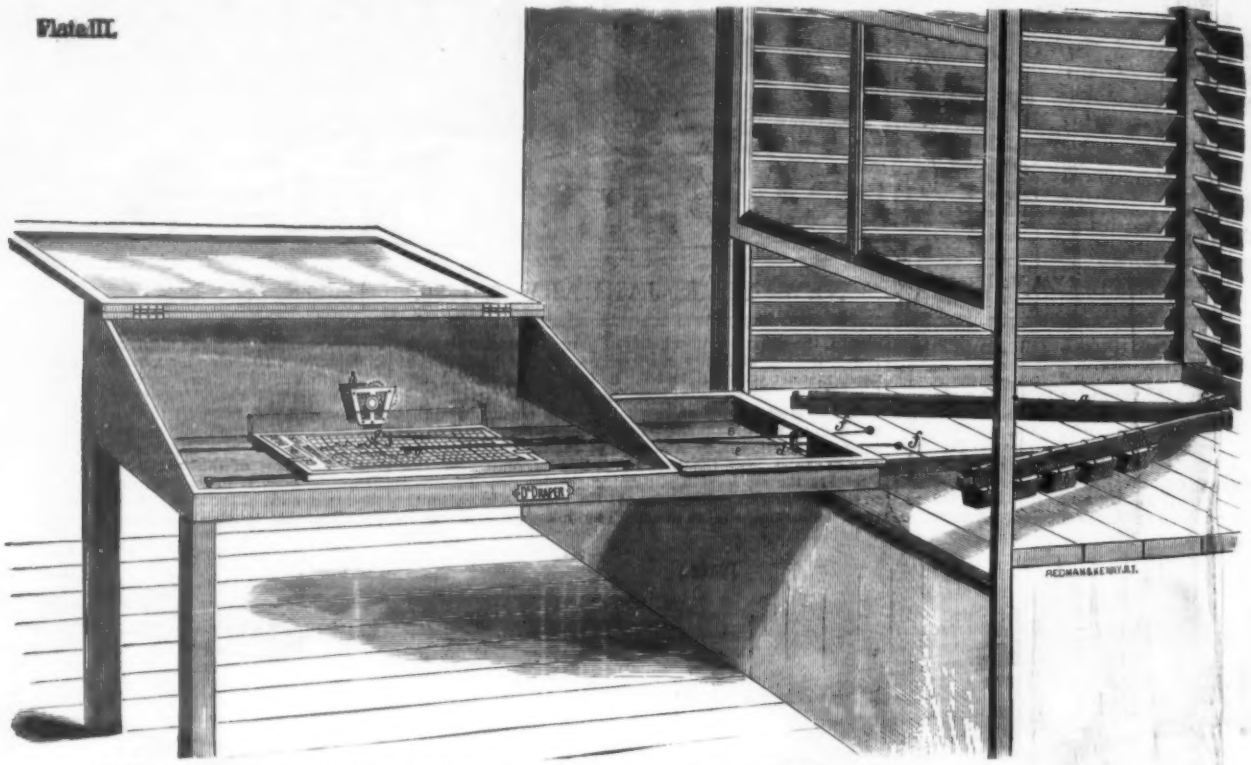
Plate II.



DRAPER'S

SUN THERMOMETER.

Plate III.



DRAPER'S PENCIL THERMOMETERS, (DRY AND WET.)

Plate V

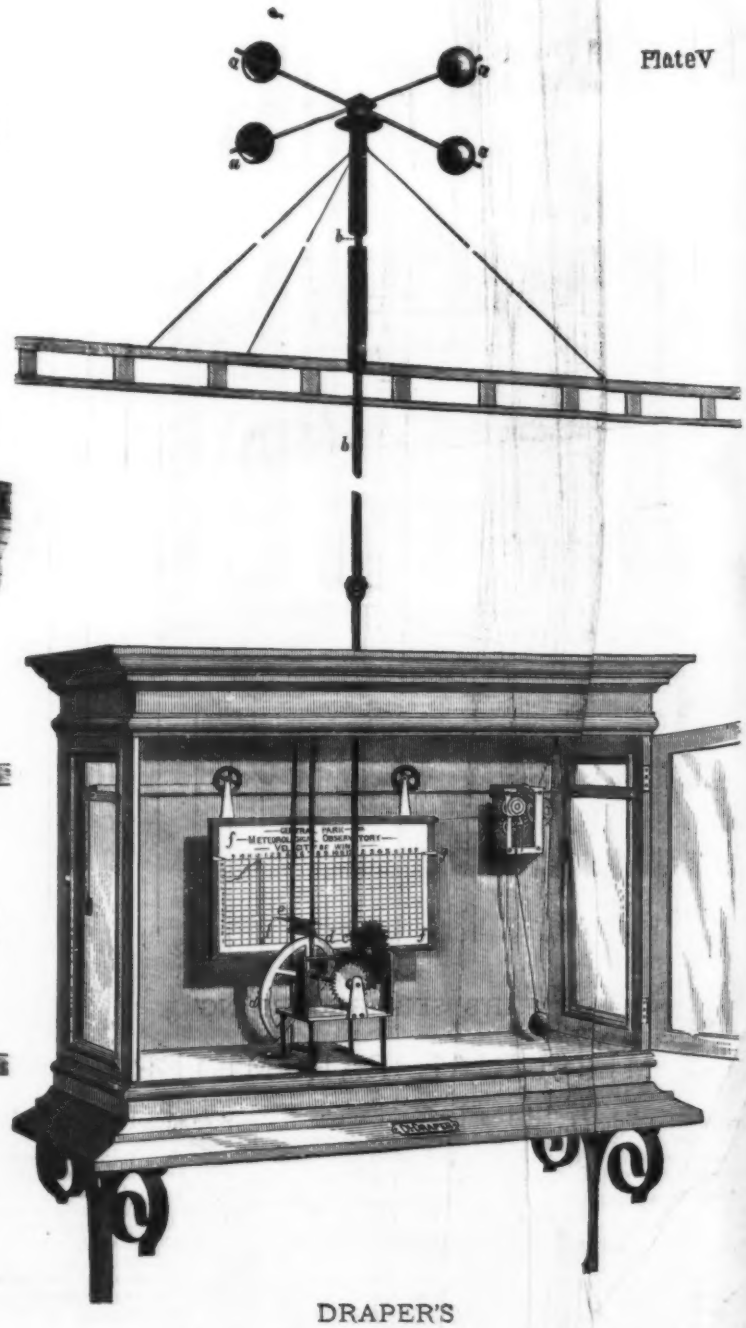


Plate IV.

DRAPER'S

DIRECTION OF WIND.

DRAPER'S

VELOCITY OF WIND.

again. By repeating this operation several times a very good vacuum will be secured with less stickiness than if it had been boiled. The filled tube is now ready to have its open end inserted in the permanent reservoir. The plan adopted is first to melt a small quantity of wax in the bottom of the reservoir; when it is cold invert it over the open end of the filled tube, then placing the finger on the bottom of the reservoir with a slight pressure embed the tube in the wax, at the same time invert the tube and reservoir together, pour a little mercury into the reservoir, now gently lift the tube from the wax, the mercury in the tube will subside to the barometric height at the time. The tube and reservoir are now ready to be placed in their frames in the case.

The springs for weighing the reservoir are made of steel wire, number 22 English wire gauge, closely wound round a mandrel, ¼ inch in diameter and 10 inches long, on which they are tempered hard, and afterwards lowered to a suitable temper by being dipped in oil and ignited two or three times, the burnt oil forming a japan that prevents them from rusting in damp weather.

Steel springs for instruments are generally made too short and thick, that is, there is a very small range between their normal condition and limit of elasticity. These barometer springs may be stretched five times their length without taking a set, while in the instrument they are never extended more than twice their length. Heat has a slight effect on them, causing them to lengthen about $\frac{1}{1000}$ of an inch for 90 degrees Fahr.; to allow for this, a third spring, *d*, is weighted with a lead weight and pencil, it marks its fluctuations on the upper line of the register sheet. Otherwise this instrument gives the correction for temperature (or reduction to 32°) from the fact that it weighs the mercury instead of measuring its length, which is affected by heat.

Ink pencils of the barometer and other instruments are made by drawing narrow glass tubing to a fine point, which lightly touches the paper register, leaving a mark of red ink that has been diluted with about one quarter of its volume of glycerine. The glycerine prevents the ink from drying too rapidly. The advantage of this form of pencil over lead ones is that it requires little or no pressure to produce a mark.

To receive the atmospheric fluctuations a suitable ruled paper is fastened by means of small brass clamps, *k k*, to the board, *h h*, which is hung by rollers to the thick steel rod fastened to the sides of the case, on which the paper is carried from right to left by the clock, *i*, at the rate of ½ an inch per hour, by means of the pulley on the hour arbor of the clock. The wire that connects the register board to the clock is soft steel, number 28 wire gauge; having only one turn round the pulley it readily slips so that the board can be pushed sideways for the adjustment of time, or for the renewal of the sheet of paper.

II.—DRAPER'S SUN THERMOMETER.

This instrument is constructed on the same principle as the dry-bulb thermometer, except that the metallic bar is inclosed in a glass shade, 4 inches in diameter and 20 inches long, mounted 2 feet above the roof, and exposed to the direct rays of the sun. There is no vacuum in the glass shade; it only serves to keep the wind and rain from the bar. The bar is connected by a wire to a lever multiplying four times in the room below, in which is placed a case with its clock, lever, register sheet, etc.

DESCRIPTION OF INSTRUMENT—PLATE II.

Extending from the instrument in the room through the roof is an iron pipe, *a a*. On its upper end it carries an iron bar, *b*, to which is fastened firmly, at *c*, the metallic thermometer bar, *d*; from the loose end of this bar a fine wire descends over a guide pulley down the inside of the pipe to the lever, *e*, in the case in the room below. On the long end of the lever is an ink pencil, *f*, that records the motions of the thermometer bar on the register sheet, *g g*, which is fastened by means of two small clamps to the board that is carried sideways by the clock, *h*. Over the metallic thermometer bar above the roof is a glass shade, *i*, protecting it from the weather.

On the register paper, *g g*, are shown the fluctuations for the day. In this instance many clouds have passed between the sun and instrument. If the curve had been without oscillations it would show that the day had been clear. The readings of this instrument follow closely those of Casela's Maximum Vacuum Thermometer, with this advantage, that the time of maximum heat is known, and if it was a clear moonlight night the record will read several degrees lower than the thermometer in the shade, or louvre box; this lower reading is due to radiation into space.

I hope soon to have one of these bars mounted as a wet thermometer in the sun, so that the difference in the readings with those in the shade may be compared.

III.—DRAPER'S PENCIL THERMOMETERS (DRY AND WET).

After experimenting with many different substances, such as brass and glass, hard rubber and brass, I eventually found that iron and zinc gave thermometer bars most suitable for meteorological purposes; they may be graduated from zero to the boiling of water without changing their condition. After many hundred trials it was found that when two strips of zinc were riveted to one of iron, the best results are obtained.

DESCRIPTION OF INSTRUMENT—PLATE III.

The portion of the instrument represented as projecting out of a window towards the north, consists of the dry and wet thermometer bars fastened to the same iron frame, the loose ends pointing towards the room, and connected by light link rods to the short ends of two levers, which carry on their long ends ink pencils that mark the fluctuations on the register sheet.

The curved bars, *a a*, consist of two strips of zinc, each $\frac{1}{16}$ of an inch thick by 1 inch wide and 20 inches long, riveted on the same side to a similar single piece of iron. On warming this bar it curves from the zinc side, that metal being more expansible than iron. If cooled, the reverse takes place. On the right hand bar there are several small troughs, *b b b*, with cotton threads to convey moisture to it. This part of the apparatus represents a wet-bulb thermometer. Several troughs are used, so that when the cotton becomes frozen in cold weather it will not resist the bending of the bar, as would be the case if there were only a long single one. These bars are firmly fastened to the iron bar, *c*, which returns to the case in the room; on this is raised a pillar, *d*, which acts as a fulcrum to the slender brass levers, *e e*, one end of each lever being fastened by the connecting links, *f f*, to the loose ends of the compound bars, *a a*. On the other ends of the levers are ink pencils, *g g*, one containing red, the other blue ink; these mark on the register drawn by the clock, *h*, towards the left hand, the movements of the metallic bars, as is depicted on the register sheet, which is divided into degrees by the straight lines, and into hours by the curved lines.

The sensitiveness of these bars to sudden changes compares very favorably with the readings of the standard thermometer. This is not more than might be expected from the large surfaces they present to the weather.

IV.—DRAPER'S DIRECTION OF WIND.

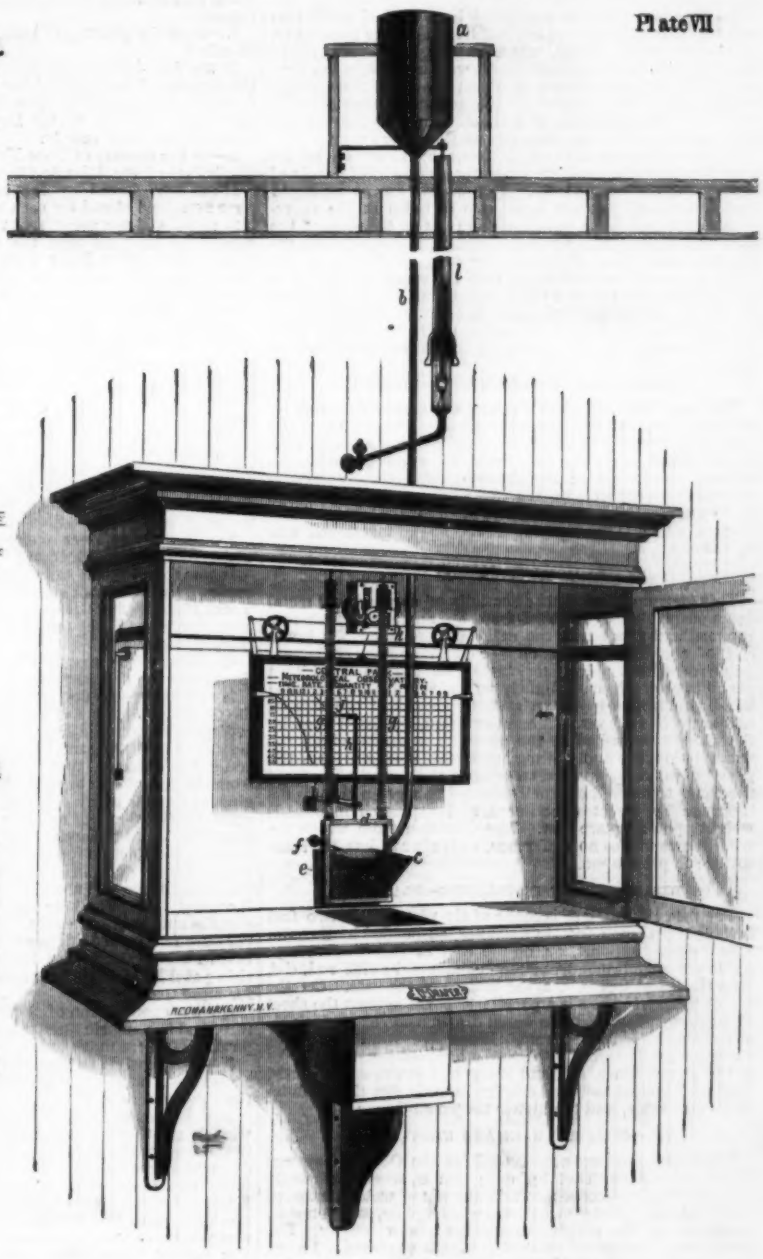
From the wind vane placed several feet above the roof descends a vertical shaft, to the lower end of which is fastened a brass cylinder, which carries a register sheet of paper to receive the oscillations of the wind. A pencil bearing

Plate VI.

DRAPER'S

FORCE OF WIND.

Plate VII.



DRAPER'S

RAIN AND SNOW GAUGE.

lightly against the paper descends from the top to the bottom of the cylinder in the course of twenty-four hours; its movements are regulated by a clock. When the wind shifts the paper register therefore correspondingly turns, and the pencil makes a trace of the movement; if the wind is lulling the pencil makes a straight line downwards. On the sheet of paper are printed lines for the four cardinal points, N., E., S., W., and the hours of the day, the trace thus showing the direction and all the variations of the wind, and the time of their occurrence.

DESCRIPTION OF INSTRUMENT—PLATE IV.

The wind vane, *a a*, 15 feet above the roof of the building, the vertical shaft, *b b*, which is fastened to and turns with the vane, and gives corresponding movements to the brass cylinder, *c c*, round which the register paper is fastened. At *d*, is a pencil tube attached to the top of the weight, *e*, and the pencil bears lightly against the paper by an India rubber elastic spring. A clock, *g*, permits this weight to descend to the bottom of the cylinder in twenty-four hours, when the cylinder is taken out, and the register slipped off. Another one is put on by pasting one of the edges of the paper and letting it overlap the other edge round the cylinder.

V.—DRAPER'S VELOCITY OF WIND.

On the ends of a cross supported by a vertical shaft several feet above the roof of the building, are four hemispherical copper cups. These, whatever may be the direction of the wind, are caused to turn round with a speed, as has been determined by experiment, of about one-third the velocity of the wind. This portion of the contrivance was the invention of Dr. Robinson, of Ireland. It is used in the foreign observatories, and is known as Robinson's cups.

To the lower end of the shaft thus made to revolve by the cups is attached an endless screw connecting with a train of wheels, which move a cam. The wheels are so arranged that one turn of the cam answers to 15 miles in the movement of the wind. A pencil which rests on the edge of the cam, and bears lightly against a surface, is carried from the bottom to the top of the paper by each revolution of the cam. It should be understood that the paper is attached to a board drawn aside by a clock at the rate of half an inch an hour. The number of times that the pencil moves from the bottom to the top of the paper, multiplied by 15, gives the number of miles that the wind has moved in an hour or day.

DESCRIPTION OF INSTRUMENT—PLATE V.

The four hemispherical cups, *a a a a*, turned round by the wind, impart their motion to a vertical shaft, *b b*, at the bottom of which is the endless screw, *c*, its lower end resting in a small agate cup filled with oil, connected with the train of wheelwork turning the cam, *d d*. At *e*, is the pencil resting on the edge of the cam; *f f*, is a sheet of ruled paper attached to the board, *g g*, by means of small brass clamps, which is drawn aside at the above mentioned rate by the clock, *h*.

VI.—DRAPER'S FORCE OF WIND.

This instrument consists essentially of a cylindrical metal drum suspended by a chain from an unyielding frame or support, and exposed to the action of the wind, the lower end of the drum being connected by another chain and guide rod with a spiral steel spring, on the top of which a pencil is placed bearing lightly on a sheet of paper fastened to a board, which is drawn aside by a clock at the rate of half an inch an hour. When the drum is pressed upon by the wind it is pushed in the direction towards which the wind is blowing, and pulling upon the spring causes the pencil to make an upward trace upon the paper. The force necessary to draw the pencil upward to a given point is determined by direct experiment, and expressed in pounds weight upon a square foot. The direction from which the wind blows makes no difference, as it always has the same surface to press upon.

DESCRIPTION OF INSTRUMENT—PLATE VI.

The metal drum, *a a*, is made of tin plate; it is two feet in height and one foot in diameter, suspended by a chain, *b*, to a strong support, *c c*, on the roof of the Observatory; its lower end is connected by a chain and guide rod, *d d*, with the spiral spring, *e*, at the bottom of the case. On the top of this spring at *f* is a pencil; it bears against the sheet of paper, *g g*, fastened to a board drawn aside by a clock, *h*, at the above mentioned rate. When the wind blows, the tin cylinder is forced into some other position, as is shown in the dotted figure, *d d*, and the pencil is drawn upwards. The more violent the wind the further will the tin cylinder be pushed aside, and the higher the pencil drawn.

VII.—DRAPER'S RAIN AND SNOW GAUGE.

The first rain-gauge constructed for the Observatory was on the principle of Tantalus' cup; that is, when the receiving vessel had collected a certain amount of water it emptied itself into another by means of a glass siphon, and returned to the top of the register to receive a new supply. But sometimes it happened that small insects or pieces of leaves, etc., would choke the siphon, either retarding or stopping it from emptying the receiver. This led me to the construction of another, on the principle of a gravity bucket; that is, after a certain amount of water has been received in the bucket it tilts so as to empty all the water out, and after doing this returns to its former position. This gauge multiplies ten times, so that rain-falls of one hundredth of an inch may easily be measured.

DESCRIPTION OF INSTRUMENT—PLATE VII.

About two feet above the roof of the building is placed the usual circular rain gauge receiver, marked *a;* it is 8 inches in diameter, funnel-shaped at the bottom, and leads into a block tin pipe, *b*, three-eighths of an inch in diameter. This gauge is mounted on a square box that will be described below. The pipe descends from the gauge to the receiving or gravity bucket, *c*, which is made of brass and is of a triangular primastic shape, balanced just above and forward of its center of gravity in a square frame, *d*, by two pivots, one of them marked *e*. These allow it to tilt when the water has reached a certain height or quantity. The leaden weight, *f*, is an adjustable counterbalance for the regulating of the tilting of the bucket. The square frame which carries this bucket is suspended to two steel springs, *g g*, placed as is shown in the drawing, that is parallel to the register sheet, the object being that when the bucket is emptying, the pencil rises from the register and makes no return mark. The upper ends of these springs are fastened by suitable means to the top of the case. Between the springs and attached to the square frame is an upright rod, *h*, going through a steadying bracket, *i*, and on its upper end an ink pencil, *j*, which delicately touches the sheet of paper moved sideways by the clock, *k*.

The square box alluded to in the preceding paragraph not not only affords a support for the gauge, but retains warm air admitted from the gas-burner in the room below by means of an iron pipe, *l*, which delivers the heated air close to the bottom of the funnel, melting any snow or sleet that may collect. There is also a metallic thermometer bar in it, which controls a valve at the lower end of the iron pipe, so that the temperature at the bottom of the gauge shall not rise above 40 degrees Fahrenheit.

In the Observatory, besides the foregoing self-recording instruments, there are the usual standard instruments, as mercurial barometer, aneroid barometer, mercurial thermometers, hygrometers, pantograph for tracing photographic curves, polar planimeter for measuring the mean value of the different curves given by the self-recording instruments, microscope, spectroscopes, thermopile, galvanometer, etc., for examinations of various meteorological conditions of the air.

We cannot close this paper without expressing a hope that the Commissioners of the Department of Public Parks will put in force the suggestion of Mr. Draper for the construction of a new and more suitable observatory in the Central Park.

We subjoin a few interesting remarks and observations made by Director Draper, as given in some of his previous reports:

1.—Does the clearing of land increase or diminish the fall of rain?

It was found that the wide-spread public impression that the clearing of land diminishes the volume of rain is not founded on fact. This question is of the utmost importance to the Croton Water Department of this city on account of the water supply.

2.—Is the climate of New York changing, or more generally is that of the Atlantic States undergoing modification?

It has been found by the number of days the Hudson river remained closed for each year since 1817, when divided into periods of ten years, that there has been no important change in the time that the river has remained frozen. These observations differ from those of the thermometer, since they represent the quantity of heat over a long line of country, while those of the thermometer give merely the intensity of heat at the special moment and locality. On an examination of the winter thermometer observations for New York, Philadelphia, Boston, and Charleston, the general conclusion arrived at was that there has been no change in the lapse of many years; none can be substantiated as having occurred within the century. This proves that surface changes through agriculture, drainage, etc., give rise to no appreciable meteorological effect.

In many parts of the United States there are prairie or treeless regions, several hundreds of square miles in extent, yet these are not rainless because they are treeless; clouds drop water upon them to the same amount that they do on the neighboring wooded lands.

3.—Has the summer temperature of the Atlantic States undergone any modification?

It was found by an examination of the thermometric records of the three hot summer months of the year for New York, Philadelphia, Boston, and Charleston, that there had been no change in the temperature, when considered in periods of five years.

4.—What is the direction in which atmospheric fluctuations cross the United States?

My attention was first strongly drawn to this subject by the disaster which befell a large number of deciduous and evergreen trees in the spring of 1872. Of these there were destroyed in the Central Park alone nearly eight thousand, and it was estimated that there were killed in the country from the Atlantic to beyond the Mississippi, and from Virginia to Canada many millions. It was recognized that this great destruction was due to a sudden cold which occurred about the 13th of March. It first appeared in the region between the Rocky Mountains and the Mississippi River. It had a front of at least a thousand miles; the velocity of this disturbance was about 500 miles per day. On the 14th it crossed the space between the Mississippi and the Alleghanies and went out to sea. At this Observatory the temperature fell from 51 degrees to 17·2 degrees. Every tree branch was covered with icicles, and the temperature not rising at 2 P. M. higher than 27 degrees, they did not melt for more than a day.

On an examination of several storms of rain, temperature, and barometric fluctuations, I found a very large proportion of them moved from the west toward the east.

5.—Is it possible to trace the passage of American storms across the Atlantic, and predict the time of their arrival on the European coast?

If these meteorological waves cross the United States, why should they not also continue their course and cross the Atlantic Ocean? In a discussion of the atmospheric disturbances which left New York from 1869 to 1873, it was found that 86 out of 89 of those selected were felt on the European coast. This tends to disprove the common assertion made both here and in Europe that there is no connection whatever between the storms of the two continents. For several years it has been affirmed that the American storms cease on the coast of Newfoundland.

6.—Do American storms cross the Atlantic to Europe?

As much interest had been expressed on this interesting topic, I was led to show by a chart that such storms not only reach Europe, but they are felt all the way across the Atlantic by steamships; and the time of their arrival in Europe may be predicted within certain limits.

Since the publication of this report the proprietor of the New York *Herald* has had telegraphed to Europe the predictions of American storms about to appear on the European coast, with great success.

In the United States Signal Service international weather maps for January, 1879, there are several well marked disturbances that have crossed the Atlantic from the American coast.

7.—Has there been in late years any change in the rain-fall of New York City or its vicinity to affect seriously its water-supply?

The conclusions arrived at were that the rain-fall of New York was increasing until 1869; it then showed a tendency to decrease; and that there are undoubtedly cycles of rain-fall as there are cycles in sun-spots, and other astronomical phenomena, occupying many years for their completion.

The rain-falls of other places, as Washington, Philadelphia, Providence, were consulted to see if the variations in the New York observations were due to local causes. It was found that they all showed the same general peculiarities.

8.—Does the rain-fall of New York still diminish, will it continue to do so, and does this variation occur in the early or latter portion of the year?

From the observations used, it appears that the rain-fall of this city will most probably continue to decrease by fluctuations for several years to come, and that the variations are nearly the same in the two portions of the year.

As the rain observations of this country do not date back for a long period, those of Paris (France) were consulted. They extend back 190 years. It was found that during that period there had been a slight increase in the rain-fall, not steadily, but with three oscillations of many years each.

[Continued from SUPPLEMENT, No. 208.]

CENTRAL AFRICA.

By REV. JOHN O. MEANS, D.D.

5. In the extreme south is another region, suggested specially by a gentleman who was a member of the Universities' Mission in their earliest movements near the Shirè and Nyassa, who traversed the country about the lower Zambesi, was with Bishop McKenzie when he died, was a trusted companion of Livingstone, and the editor of Livingstone's "Last Journals." This is the region of Mt. Gorongoso. "If I were going out to Africa again as a missionary, I should choose this of all places." The mountain lies south of the Zambesi, not far from Senna, and not far from the ocean. The Jesuits, who are credited with great foresight in selecting strategic points, in their palmy days in Africa had a mission here, of which the ruins are still visible. The country about is spoken of as most attractive; a healthful, fertile, beautiful country. The tribes are of the Zulu stock and language. Access would be very easy.

This region, known of old as Monomotapa, is now the kingdom of Umzila, who hitherto has positively refused to allow missionaries in his dominions. It is intimated that now he is willing to receive them. The Landeens and other roving freebooters, between Gorongoso and the Zambesi, have given great trouble to the Portuguese. It is believed, however, that American missionaries would have nothing to apprehend from them. Natal is not far distant, and the mission there could be helpful in this region. Indeed, it may seem best to expand the Natal mission and extend it up to this neighborhood, instead of making Gorongoso a new and special Central African mission.[28]

6. Gorongoso is near the mouth of the Zambesi. Away up near the sources of the great river, above Victoria Falls, in the Barotsé Valley, is the sixth region suggested for a new mission.

This Barotsé Valley is a great tract of country, ten or twelve hundred miles from the mouth of the Zambesi, of a fertility like that of the lower Nile Valley, owing its rank luxuriant growths to similar river overflows. It is about midway between Benguela on the Atlantic and Mozambique on the Indian Ocean. Some of the oldest South African missionaries and officers of societies, English, Scotch, and German, have urged its occupancy as one of the most desirable places. The French Basuto missionaries have explored the ground and attempted to plant a mission. After some months' residence, having buried two of their explorers, they have withdrawn south again. It has been said that it was altogether unlikely our French brethren would take this field; that they could hardly do so, as their resources were needed for work already in hand; and by all means it was declared, if they should not, the American Board ought to undertake this field.

One specific object of the visit to Paris was to learn from headquarters what the Société des Missions Evangéliques, proposed to do as to the Barotsé Valley. It was found that this society had cheerful expectations of occupying it; that the question was to be decided in October, at the Conference of the Basuto Mission Churches in South Africa; that it depends upon the willingness of the Basuto Christians to take up this work. It is believed, at Paris, that they will do so.

Major de Serpa Pinto traveled through this country. In answer to special inquiries about it, in a long interview at Paris, he represented it as utterly unsuitable for missionaries. In the rainy season, for six months of the year in fact, the country is a complete swamp, for leagues and leagues, both sides of the river, which becomes a wide lagoon. The natives have their huts on slight elevations, with water all about them. It is extremely unhealthy even for native Africans. On the simple score of the malaria, which mows down the blacks themselves, Major de Serpa Pinto would discourage the establishment of a mission there. He was to talk with the Committee of the French Mission, by their request and appointment, the day after this interview, and doubtless repeated these statements to them. An English friend, Dr. McColl, who is now preparing to go to the Congo as a missionary explorer, and who has been through the Barotsé Valley, gave the same account of it. Indeed, we find, what had previously escaped our notice, that Dr. Livingstone took companies of Makololos, in search of new homes, into this Barotsé Valley, and it proved so unhealthy the Makololos could not live in it, for all its attractiveness otherwise.

At one time, and that quite recently, it looked as though all things were pointing to this region as the one of all Central Africa for the Board to occupy.[29]

There remain to be mentioned two more great fields, which come last, because, in fact, attention was called to them last; in importance probably they should have been put first.

7. One of these, the seventh region suggested, is that of the Portuguese Concession on the Zambesi.

The Portuguese for two or three hundred years have claimed, and to some extent exercised, rights on the Zambesi and almost across the continent, from Benguela to Mozambique. About the Lower Zambesi, at Senna and at Tete, the Portuguese have long had forts and officials. At one time they had a settlement at Zumbo, five hundred miles up the river. There was a Jesuit church there, of which the ruins still remain, and the broken bell was lying on the ground in Livingstone's time. Within a few years the deserted Zumbo has begun to be reoccupied, and is growing into commercial importance.

To develop the marvelous resources of this great region, the government at Lisbon has made a concession of rights

[28] Stanford, "Compendium," "Africa," chapter 24. "South Africa and its Mission Fields," by the Rev. J. E. Carlyle, late Presbyterian Minister and Chaplain, Natal. 12mo, 1878, chap. 20, p. 294; chap. 23, p. 286. Livingstone: "Narrative of an Expedition to the Zambesi and its Tributaries, and of the Discovery of the Lakes Shirwa and Nyassa," 1858-1864, by David and Charles Livingstone. 8vo, 1865, chap. 1. "Livingstone's Travels in South Africa," chap. 32.

[29] Livingstone; "Travels in South Africa," chapters 8-16, 23-27. "Expedition to the Zambesi," chaps. 12-15. "Journal des Missions Evangéliques de Paris," for March, 1876, to July, 1879, containing M. Coillard's papers touching the Barotsé Valley.

Major de Serpa Pinto. Report at Lisbon, notes of which are given by a correspondent in the London *Standard* of June 22 and 23 (1879). Report to the Royal Geographical Society, London, July 16, 1879, in "Proceedings of Royal Geographical Society" for August, pp. 481 *seq.*

and privileges to a commercial company. By a decree dated December 28, 1878, the government accorded to M. Paiva d'Andrada and associates the ownership of all mines of guld, copper, iron, and coal now known in a vast territory on the Zambesi and its affluents; the monopoly for twenty years of working all mines that may be discovered; the monopoly for twenty years of the forests; and the ownership of 250,000 acres of the best lands for agriculture and colonization. The Concession covers the whole basin of the Zambesi, from where the Shiré joins it eighty miles from the ocean up to the Nyampanga Island, six or seven hundred miles inward, where the great Cafue empties its swollen waters from the north and west into the Zambesi, as the Zambesi itself comes streaming up from the Victoria Falls and the south, and by a great bend swings away eastward to the ocean. From the 14th degree of south latitude, near the foot of Lake Nyassa, the Concession includes the territory to the 17th degree of south latitude, about 9,000 square leagues.

M. d'Andrada has formed an international syndicate to manage this Concession. The legal office is at Lisbon, the board of directors with full powers are at Paris, where the business will be done. A company has been formed; the capital of one and a half million francs in five hundred shares has been quickly taken up, bankers competing for the stock. Arrangements are making to send at once—there are probably now on the way—scientific and commercial exploring parties, to obtain minute and exact information. There is talk of introducing colonists from Europe or Asia.

That this country is very rich there can be little doubt. Gold, copper, and iron have been obtained in past years to some extent. For miles the river runs through a rich carboniferous formation; there are numerous outcrops of coal; from some of them Livingstone procured fuel for the steamer he took up the river. The forests abound in ebony and dye-woods, and the caoutchouc tree. Sugar cane, tobacco, opium, cotton, coffee, have all been raised. The climate is said to improve as the interior is reached. The river is navigable half way up the Concession to the first cataracts between Tete and Zumbo.

Perhaps at Zumbo, 500 miles from the ocean, where the great river Loangwa or Aruangoa comes down from the southern slope of the Lokinga Mountains, and from the ridges and table-lands between lakes Nyassa and Bangweolo, there may be found a healthy and commanding position for a mission. The approach to it will not be difficult. Natal might be in easy communication with Zumbo. The tribes around are of the same great Bantu family with the Zulus, and the languages are kindred. Away northward, around the head waters of the Loangwa, are said to be large populations. Probably from Zumbo, Chitambo's Land, near Bangweolo, is to be reached most easily, and so also Cazembe's Kingdom, famous of old as one of the mighty kingdoms of Africa. The neighborhood is not far from that of the Scotch Missions about Nyassa, and mutual cooperation might be possible. So far as is known, no Protestant society has it in contemplation to establish missions in this Concession.

"Here, I exclaimed," said a gentleman of Glasgow, one of the committee of the Livingstonia Mission, and of the Central African Trading Company, "when I read about this Concession, here is the place for a mission! Some strong society ought to go in here at once; it is a great opportunity."

With all that looks encouraging on the surface, we must not fail to observe that as yet we see little more than the surface, and shall do well to wait till explorations in progress shall furnish more thorough information

All agree that a region which has been long under Portuguese control, or influence even, is not hopeful for Christian work. This region has been long under evil influence, a part of it has been for two centuries the center of the most corrupting, not to say the vilest, influences; the foulest atrocities of slave-stealing and slave-trading have been committed here; the most loathsome vices of penal criminal communities have sunk the populations, drawn or drifted in here, lower than the ordinary depth of even African barbarism.

The Portuguese government of to-day seems desirous of sweeping away the evils of the past. It is joining other nations in legal enactments against slavery. It has thrown open the Zambesi to the free trade of all nations. It is sending skillful and courageous officers to explore and develop the vast tracts which have so long been known only to the Pombeiro and the Arab.

The fact that here is to be started a commercial enterprise, into which may be drawn a motley company of all and of no nationalities, eager for wealth, is of course to be taken into account. The same, in its measure, however, is true, or will be true at Lake Nyassa, and Tanganyika, and at Victoria Nyanza, and at all the great centers, where various societies are planting themselves. One result of successful labors indeed is to develop commerce and quicken industrial enterprises, and make men eager to better their fortunes; and if a field was found far inland among primitive people, as fast as the mission elevated the natives, it would stir them up to buy and sell, and get gain by thriving industries.

The scheme of introducing European and Asiatic colonists is also to be kept in mind in considering this field. But even if colonists in great numbers should come, it may be said that this region would be no worse for mission work than South Africa. Even there the natives are not yet swamped by the colonists, and are not likely to be in this generation.[40]

Whatever, on the whole, be the balance of advantages or disadvantages of this region or a field for establishing a mission—Dr. Livingstone was planning to have several societies plant missions on this great river, and declared there was widest scope for any number of separate societies not to interfere with each other—it is just now exciting extraordinary interest, and is giving promise of more rapid development than any other portion of this long sealed Central Africa.[41]

8. There is one other, the eighth and last, region suggested for the new mission, and which, so far as present information should influence the judgment, perhaps should have the preference. It is the region of Bihè and the Coanza.

Bihè is an elevated plateau, or rather a rolling country, some two hundred and fifty miles inland from the Atlantic Ocean. It lies back of Benguela, in about 12° south latitude. The Coanza or Quanza is the most important river south of the Congo to the Orange; steamers are now running to Dondo, one hundred and twenty miles from the Atlantic, where there are cataracts, and above these there is transportation farther by small boats. The spring heads of the river are in Bihè, and for missionary purposes Bihè and the Coanza may be named together.

The important points in a country, as Bishop Steere well says, are those which trade has developed. Bihè is a great caravan center. The only route across the continent, south of the Niger, passes through Bihè; there the road branches off for Nyangwé, on the Upper Congo, for Muato Yanvo's Kingdom of Ulanda, and for the Cazembe, Lake Bangweolo, Tanganyika and Nyassa, and for the Senna rivers so called, on the Lower Zambesi, and Mozambique. The climate of Bihè is said to be delightful; the elevation of four or five thousand feet moderates the tropical heats. The land is well watered and fruitful. Some Portuguese blood has been mingled in the population, but in the main the tribes show all the marks of the great Bantu family, which occupies this central region of the continent and spreads through Zululand southward. The language is of the same Bantu family, though many Portuguese words have come in from the western, and Suaheli words from the eastern coast, and these two languages suffice for travelers.

The first and great consideration in favor of this region is its healthiness. One reason why advances to the interior have been undertaken from the east coast is because this seemed less unhealthy than the west coast. Even on the east side of the continent, the *Mrima*, as the low, swampy, pestilential sea-coast is called, has a breadth, opposite Zanzibar, of one or two hundred miles, which must be traversed by slow stages, and where disease is contracted before the healthier upland is reached. On the west side of the continent, north of the Congo, the sea-coast is everywhere low and swampy; dense mangrove thickets breed pestilential fevers. There is a wide belt of this miasma before the foot hills are gained. With a slight break at the Cameroons, this is the character of the west coast from the Congo, around the Bight of Biafra and the Bight of Benin and the Gulf of Guinea to Cape Palmas and north of Cape Mount clear up to the Senegal. From the Congo, southward, begins a change. South of this oceanic estuary the mangrove and the swamp mud disappear; shingle and sandy reaches commence, and scant vegetation covers the narrow border between the sea and the hills. Angola and Benguela, on this sandy sea-coast, are declared by Monteiro, who lived there many years, to be healthy. A short distance from the ocean the hills rise into the first plateau; a little farther inland the loftier second plateau begins, and as you advance the scenery is so attractive that Commander Cameron, foot-sore and weary with his march across the continent, stopped, and gazed and gazed till he forgot himself, and imagined he was looking upon the parks and pastures of England. "Neither poet, with all the wealth of word imagery," he asserts "nor painter, with almost supernatural genius, could by pen or pencil do full justice to the country of Bailunda."[42] "In all tropical Africa," says Major de Serpa Pinto, "this is the territory most suitable for European colonization. Bihè, forming the southern limit of the Benguelan highlands, stands five thousand feet above the level of the sea, and possesses great advantages in its salubrity and its commercial and agricultural capabilities, which highly recommend it to European attention."[43]

The next great consideration in favor of this region is, that there seems to be more approach to a large compact kingdom than in most places. The king of Bihè appears to be a great personage. His capital, Kagnombe, was the largest town Cameron found in crossing the continent, and Cameron passed through Mpwapwa, and Mirambo's town, Ujiji and Nyangwé, and other great centers.

The two first things to be sought for in a mission field, say those of largest experience in African missions, are a healthy locality and a compact and populous tribe. Livingstone makes healthiness the one essential. But another main obstacle to permanent results is the fact that Africa is covered with petty tribes, which are isolated and shifting, and have no mutual coherence. This is both cause and consequence of slave-stealing forays. "It may be fairly accepted," says Mr. Hutchinson,[44] "that the obstacles which have barred the spread of a higher civilization in West Africa have been mainly two: first, the deadly climate; and, second, the politically incoherent, unstable character of the people, caused partly by the disintegrating influence of the slave-trade." Sir Barile Frere quotes and confirms this declaration.

As to healthiness, Bihè, if accounts can be trusted, would seem to be pre-eminent. As to having within reach a numerous population likely to spread the Gospel when they receive it, it also seems to be pre-eminent. "Bihèans," says Major de Serpa Pinto, "traverse the continent from the equator to the Cape of Good Hope. I have visited many tribes who had never before seen a white man, but I never met with one who had not come in contact with the inhabitants of Bihè. Great expeditions depart from there carrying merchandise."

It is a third consideration in favor of Bihè that through it the central barbarism will be attacked on its western side. Many and great societies are working in from the east; only two are working from the west, and they are but just beginning, and both are on the Congo. Through Benguela there is an open approach to a region which no other society, as far we know, is occupying, though it is vast enough to employ the energies of several societies.

A fourth consideration in favor of Bihè is that it seems one of the most feasible points from which to reach the regions beyond. A mission on the Bihèan uplands should be with the view of pushing on, in due time, as the caravans push on into the interior. The predominant power of Central Africa has long been reputed to be that of Muato Yanvo, in Ulanda and Urua. For generations of travelers, Muato Yanvo and the Cazembe have been names to conjure with; they are the Great Moguls and the Prester Johns of Africa. The country adjoining Bihè is Kibokwa; then comes Lovalla, both dependencies of Muato Yanvo's, whose capital at present seems to be Kibebe, in Ulunda. In this heart of the dark continent it is that Cameron describes the ghastly savagery which accompanies the burial of a chief: a river turned from its bed, a pit dug, the bottom covered with living women, over these, as a platform, one woman planted, on her hands and knees, and on her back the corpse of the dead man, supported by his wives, crouching around him; then the earth shoveled in, while fifty male slaves are slaughtered and their blood poured over it, before the river is brought back to its desecrated bed. It would be preaching to spirits in prison to preach the Gospel here.

The access to this field of Bihè is easy, and if it should be determined upon, in case further information justifies the favorable accounts, the preliminary explorations could be made at less cost and the station be formed in less time probably than anywhere else. Ocean steamers make quick communication between Natal and Cape Town, and between Cape Town and Benguela, so that with affinity of race and of language the Zulu Mission might, doubtless, be turned to advantage here at light cost. There is a constantly-traveled route in from Benguela. The Coanza River has a line of steamboats on it, the basin of the river is now being scientifically explored to its source, and charts, on a large scale, giving minute topographical features, are published by the explorers of the Berlin Society. Dr. Nachtigal, president of the Geographical Society and of the African Society at Berlin, who traversed the Sahara and Soudan, and who now kindly puts us in possession of the charts as fast as they are issued, and of the results of the German explorers, urges that the region of the Coanza be occupied at once by Christian teachers.

The considerations to be weighed against what seems favorable in this region are: that Portuguese influence has been exercised here, and that the Portuguese government is enlarging its authority as far and as fast as possible; that, at any rate, Bihè must be reached through Portuguese territory, that it has been, and doubtless still is, a great slave-trading region; and, most important of all, to be kept in mind, that as yet our information is very imperfect as to the physical and the moral characteristics of the country and the people, especially as to their susceptibility to improvement and readiness to receive Christian teachers.[45]

It is recommended that in view of the reported healthfulness, accessibility, and density of population in and about Bihè, in Western Central Africa, and in view of the fact that no other missionary society has begun labors in that quarter, specific explorations be undertaken at the discretion of the Prudential Committee, with a view to the establishment of a mission in the region named, should further inquiries confirm the information already received; also, that investigations be continued with regard to the Portuguese Concession on the Zambesi for the possible establishment of a mission there, in case the region of Bihè prove impracticable.

THE WONDERS OF GEOGRAPHICAL EVOLUTION.

IT is to the mountains that we must betake ourselves to learn the plan of the terrestrial architecture. On the great lowlands of the world the superstructure is concealed by a deep accumulation of superficial detritus, but among the mountains the whole construction of the earth's rocky coast is laid bare. There, amid all that is grand and most impressive in nature, the chronicles of the globe must be read. The lecturer referred to the poetry inspired by mountain scenery in all times, and the desire of men to explore the secrets of the hills. He then considered the apparent complexity of mountain structure, and showed wherein the stratified rocks were a clew in unraveling the complexity. From a study of mountain architecture, he continued, we learn that the dry land has been upheaved at many successive periods, from the sea floor; that these upheavals have taken place generally along the same persistent lines, and that they were separated by prolonged periods of subsidence. After each uplift the new land has been exposed to disintegration, and its *débris* has been carried out to the sea bottom, there to accumulate into the thick masses of rock out of which future lands were to be formed. During the more important movements of upheavals, massive sheets of solid rock have been compressed, crumpled, and even rendered crystalline, and have been squeezed up along lines which have formed mountain chains. Volcanoes, too, have broken out along these lines of terrestrial disturbance, and have poured forth enormous volumes of lava from their heated interior. By revolutions of this nature, often repeated, the framework of the land has been slowly built up. During the early ages of tardy mountain growth, many tribes of plants and animals have come and gone. These reveal the fact that there have been a history and progress of organic life as well as the solid platform on which this life has been manifested. Generation after generation has passed away; species have changed, even whole types of existence have entirely disappeared, but the reports of this progress in the organic world have been preserved within the rocky framework of the land in sufficient fullness to serve as landmarks in geological history. The remains of the extinct ferns and trees, corals and shells, fish and reptiles, entombed within the mountains, becomes the clew by which the successive dates of the upheaval of these mountains are relatively fixed. They bring before us glimpses of the geography of the long vanished past—here a fair woodland with its lakes and streams; there a sandy shore bounded by bird and reptile; while often amid the rugged landscapes of the heart of a continent they tell us that there of old lay "the stillness of the central sea."
—*Prof. Geikie.*

THE "MASCARET."

IN the estuaries of the rivers of France emptying into the English Channel or into the ocean, there takes place twice every twenty-four hours a remarkable phenomenon, which, according to the locality, is called the "billow" (*flot*), "bar" (*barre*), or "reflex" (*mascaret*). Our engraving represents the *mascaret* of the 17th of September of the present year, on its arrival at Candebec-en-Caux, a pretty little village situated on the right bank of the Seine. We will try to describe the phenomenon and the causes which produce it. In the bay of the Seine at neap tide the ebb currents lose their violence, and slack water occurs. There is, in fact, at the time of low tide, a short period during which there are no currents, for the reason that the ebb and flow are in equilibrium. In the presence of the tide, however, this equilibrium is soon broken, and the waters of the river are driven into the farther end of the bay. Owing to

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[40] Carlyle, p. 4.

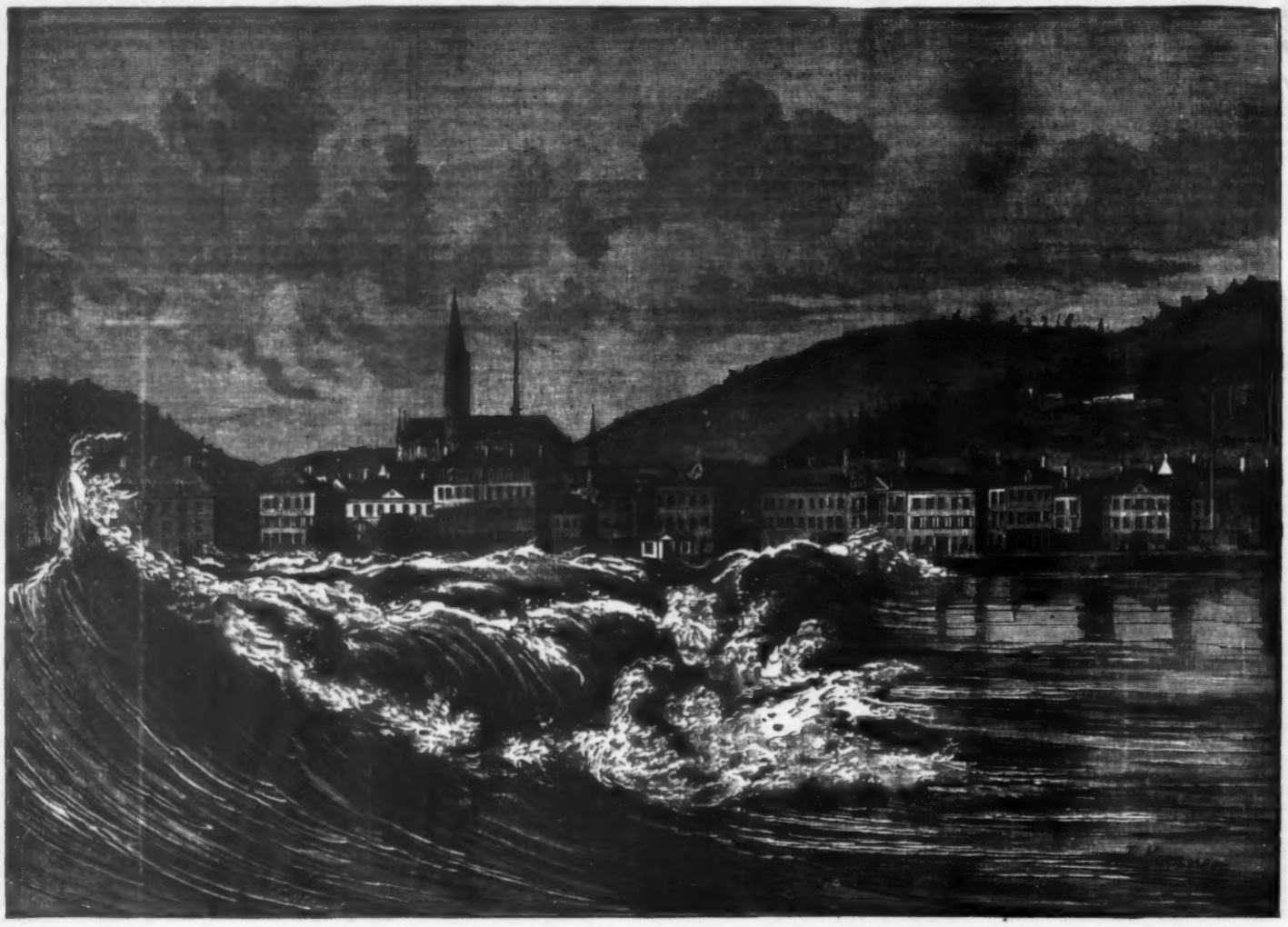
[41] Livingstone, "Travels in South Africa," chapters 28-31. "Expedition to the Zambesi," chapters 2, 3, 6-10, 15, 16, 22, 29. "The Lands of Cazembe," by Burton, Beadle, and Beke (which has an Index, as very strangely the other books do not have). Stanford's "Compendium," "Africa," chapter 24. Circular of M. le Comte d'Andrada, addressed to M. Bocande, containing the text (in French) of the Concession of the Portuguese Government, and the organization and by-laws of the Syndicate. "L'Afrique Explorée," etc., for July, 1879, p. 21, article on "Compagnie Générale du Zambèze." *Engineering*, a London illustrated weekly journal, date of April 11, 1879, pp. 310, 311.

[42] "Across Africa," ii., 230.

[43] "Proceedings of the Royal Geographical Society," August, 1879, p. 482.

[44] *Journal of Society of Arts*, June, 1876, p. 90.

[45] "Angola and the River Congo," by Joachim John Monteiro, Associate of the Royal School of Mines, and Corresponding Member of the Zoological Society. Two vols., with Maps and Illustrations. 1875, pp. x. 305; vi. 340. Livingstone, "Travels in South Africa," chapters 19-23 Cameron, "Across Africa," vol. i., chapters 1-17, 18, 19. Stanford, "Compendium," "Africa," chapters 21, 28. Major de Serpa Pinto's "Journey across Africa," "Proceedings of Royal Geographical Society," August, 1879, pp. 481 *seq.* Major de Serpa Pinto informed us that his account of his journey, in two volumes, was to be ready for publication by Messrs. Macmillan, of London, before Christmas. In "Mittheilungen der Afrikanischen Gesellschaft in Deutschland," Heft iii., June, 1879, is a long paper, the last date of which is March 7, 1879, on Loanda and the Coanza, by Dr. Buckner, of the German exploring party, pp. 139-161. Dr. Buckner speaks as favorably of the climate as does Monteiro: "On the whole, one may well say that Loanda [he refers to the City of St. Paul], not merely for a West African city, but even for a tropical city, is remarkably healthy"—page 140.



THE "MASCARET."

this fact, the waters of the ocean, meeting with an obstacle to their progress, become heaped up in the bay and produce a large swell; and the latter, urged onward by the new waters that are borne by the tide, makes a violent irruption into the comparatively narrow channel of the Seine and forces the mass of its waters into it. A considerable change takes place in the level of the water as a result of this, and the *mascaret* which is produced at this moment assumes the form of a gigantic billow extending completely across the river and rising to a height of several feet. This billow moves up the Seine with the enormous speed of 25 miles per hour; announces its coming a great way off by a tempestuous noise; and sweeping along the banks, it lays them waste. It would be unfortunate for a ship to happen to lie in its way, for it would certainly be capsized and totally wrecked. Immediately after the passage of the *mascaret* at Candebec the level of the waters arose from 118 to 130 inches.

PROFESSOR NORDENSKJÖLD.

ADOLF ERIK NORDENSKJÖLD, whose completion of that North-east Passage which has baffled explorers for over three centuries, has made 1879 an era in the annals of discovery, was born at Helsingfors, the capital of Finland, in 1832. Descended from a Swedish family long eminent in scientific pursuits, young Nordenskjöld had his inherent tastes developed alike by his surroundings at his home at Frugord, which contains a magnificent mineral and natural history collection, and by his journeys with his father, Nils Gustaf, who was chief of the Finland mining department. Thus the lad cared more for practical than theoretical learning when he first went to the gymnasium at Borgo, and on entering the Helsingfors University in 1849, devoted himself almost entirely to scientific studies, spending his vacations in excursions to the rich mineral localities of Finland. He soon became eminent in this particular branch of science, and was nominated to several appointments, but he unluckily incurred the suspicion of the Russian authorities by participation in various students' meetings, and time after time lost his appointments and was obliged to leave the country. Indeed at last for some years he was unable to obtain a passport to return to Finland. He therefore settled in Sweden, and in 1851 first entered on his Arctic travels by accompanying Torell to Spitzbergen. The traveler's life work is described at length in the highly interesting volume, compiled by Mr. A. Leslie, "Nordenskjöld's Arctic Journeys" (Macmillan), to which we are indebted for the accompanying particulars. This record embraces the career of the Professor during his twenty-one years of polar exploration, and is gleaned from the accounts either of Nordenskjöld himself, or of other sharers in the expeditions. Simply and carefully edited, the work derives additional attractions from its numerous illustrations, the accompanying maps, and the official reports contained in the appendix.

On his return to Stockholm from his first Spitzbergen journey, Nordenskjöld was nominated Director of the Riks Museum, but in 1861 he went again to Spitzbergen with Torell to obtain the measurement of an arc of meridian. The work was not finished, so three years later Nordenskjöld—although he had married meanwhile a Finnish lady, Anna Mannerheim—headed an expedition which successfully finished the measurement and mapped the southern part of Spitzbergen. The explorers, however, met with some shipwrecked walrus hunters, and were obliged to return, their provisions being inadequate to maintain so large an addition. Thus disappointed, Nordenskjöld now endeavored to organize a fresh expedition, and, aided by the Governor of Gothenburg and Mr. Oscar Dickson, to whom subsequent exploration owes so much, he eventually started in 1868, in the Government steamer Sofia, which managed to attain the high latitude of 81° 42′—a latitude only exceeded by Hall's American and the recent British Arctic Expeditions. This success convinced Nordenskjöld that he could reach a much higher latitude by wintering in Spitzbergen and utilizing sledges. Accordingly, after an interval during which he sat in the Swedish Diet, and traveled to Greenland to ascertain the respective value of dogs and reindeer as beasts of

PROFESSOR A. E. NORDENSKJÖLD, THE SWEDISH ARCTIC EXPLORER.

burden for sledge journeys, Nordenskjöld sailed in the Polhem in 1872, accompanied by two tenders, Mr. Dickson furnishing the chief funds. Misfortune, however, overtook the travelers. The winter was unusually early, and the ice shut in the tenders which were to have returned home, thereby straitening the provisions through extra mouths; the reindeer were lost, and the men suffered greatly from scurvy. Nevertheless Nordenskjöld and Lieutenant Palander successfully surveyed part of North-east land, and in the following July the vessels were extricated from their winter quarters, Mussel Bay, on the north coast of Spitzbergen, and returned home.

Finding little fresh to do at Spitzbergen, Nordenskjöld now turned his attention to Siberian exploration, and in 1875 sailed through the Kara Sea to the Yenisei, and ascended the river in a small boat, returning home overland. He repeated this voyage in the following year, after a flying visit to the Philadelphia Exhibition, but this time came back from the Yenisei by sea. By these experiences Nordenskjöld acquired a reasonable hope of accomplishing the North-east Passage. The King of Sweden, Mr. Dickson, and Mr. Sibiriakoff at once lent their aid to the project, and in July, 1878, Professor Nordenskjöld started in the Vega, on the journey which was to prove so fruitful. The events of that voyage are still fresh; we need here only recapitulate how the Vega was the first vessel to double the most northern point of the Old World, Cape Tchelyuskin, how she wintered in Behring's Straits, and, once more free, in July last reached Japan on September 2d. The Professor is now eagerly awaited at Stockholm, where he will publish the full details of his memorable voyage.—*London Graphic.*

THE MARTYRS OF SCIENCE.

FROM a work by M. Gaston Tissandier with the above title, just issued by a Paris publishing house, we extract the following narratives:

DENIS PAPIN.

IN 1707, Denis Papin published at Frankfort a little book entitled "A New Way of Raising Water by the Force of Fire," and in which he described a new system of steam engine. Later on he executed the latter on a larger scale, and applied it to a boat that he tried with success on the Fulda. In consequence of difficulties that arose with some persons of Marbourg, the inventor resolved to make his first steamboat known at London. Leibnitz endeavored to obtain from the Elector of Hanover the necessary authorization to allow the boat to pass from the Fulda into the Weser, but, notwithstanding his influence, he failed completely.

During this time Papin was experimenting with his steamboat, and obtained admirable results. "The strength of the current was such a small matter in comparison with the strength of my machine," wrote he in a letter to his protector Leibnitz, "that it was difficult to see whether it went more swiftly up or down the stream."

The inventor was preparing to embark before long with his family when he learned that the president of the bailiwick of Münden had decidedly refused to allow the passage. "After all the troubles and expenses that I have been put to by this boat," said Papin, "I find myself in danger of having to abandon it, and to deprive the public of the advantage that, God aiding, I might have procured for it by this means. I will console myself, however, seeing that it is no fault of mine, for I never could have imagined that an idea like that would have to fail for want of permission."

After a few days of new and vain endeavors, Denis Papin, becoming exasperated, determined to try and go forward. So, on the 24th of September, 1707, he embarked on his little steamboat with his wife and children, and his entire humble fortune, consisting of a few miserable household utensils. He took his station near his apparatus, started, and floated on the river, master of the winds and waves. Soon he arrived near Loch, at the confluence of the Weser. But here the fatal jurisdiction of the corporation of boatmen commenced. The president of the bailiwick of Zeune was quickly notified; and he, excited by curiosity, ran down in all haste to visit Papin's boat. He had the strange little machine explained to him, by means of which vessels could

be maneuvered without masts or sails; but, like a timid and prudent man, he soon retired without daring to protect the inventor. The next day Papin saw a great number of boatmen coming, who belonged to the corporation, and who made known to him that thenceforth his craft, which had been traveling without permission, was their property in virtue of their privileges, and that it was going to be hauled up on the bank in order to be publicly sold by piecemeal. Papin, much exasperated, protested and implored, but he was alone against all; and it was in vain that he demanded assistance from the inhabitants of the suburbs of Loch. The boatmen not wishing to lose their prey, rushed on the vessel, and, before they left it, tore it to pieces, and then began with savage fury to break up the machine and the wheels in the presence of the disheartened inventor. Thus was executed an act of barbarous destruction, which, by putting back the advent of steam navigation for a century, has perhaps modified the destiny of nations.

Later on, we find Denis Papin at London, sick and feeble. Robert Boyle, his old friend, is dead, and the new members of the Royal Society scarcely know him. The old man is still yearning for his native country, but he is more than ever a Protestant, and the religious intolerance of the close of Louis XIV's reign shuts him out from it. For a long time the inventor lived on a humble allowance from the Royal Society, in a state bordering on misery. In want of resources he was never able to renew his experiments with his steamboat. "I am obliged now," says he in one of his letters, "to put my machines in the corner of my poor chimney." Papin lived to be very old, and was the more miserable on account of having a large family to maintain.

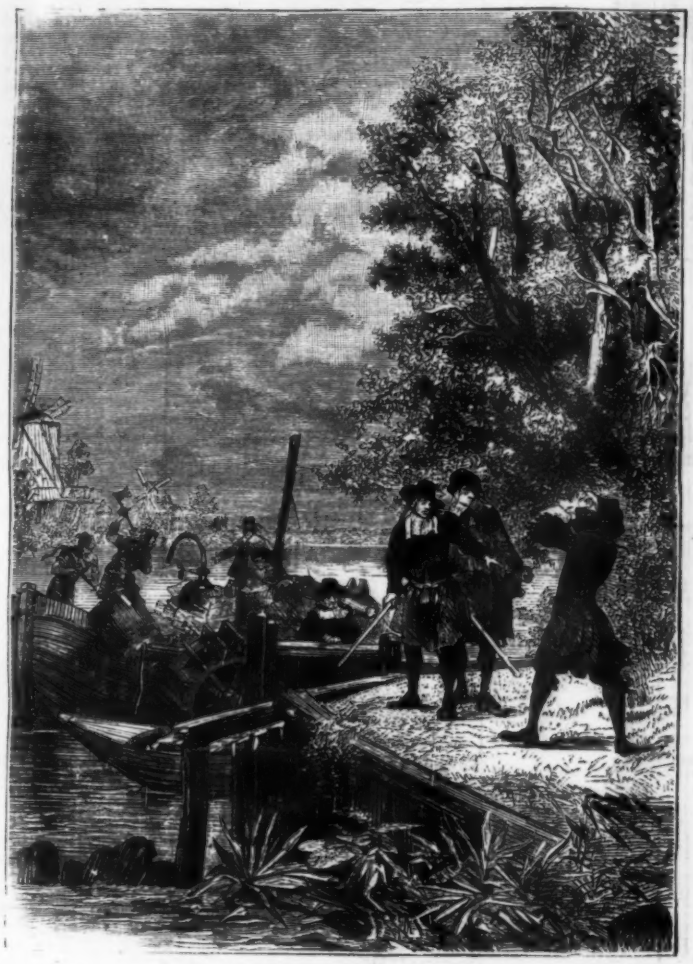


FIG. 1.—DESTRUCTION OF PAPIN'S STEAMBOAT BY THE WATERMEN OF ZEUNE.

FIG. 2.—HEILMANN OBTAINS THE IDEA OF HIS CARDING MACHINE.

The epoch of his death cannot be fixed, but it is certain that he languished for a long time in poverty and neglect.

JOSHUA HEILMANN.

In the list of inventors who have contributed to the improvement of machines for spinning, carding, and weaving cotton, we must mention Joshua Heilmann. Unlike the majority of inventors, he had a fortune which amounted (adding his wife's dowry to his own patrimony) to about $100,000; but he was possessed of the demon of invention. Living in the center of the Alsatian factories, he learned that the principal manufacturers of the locality were offering a prize of $1,000 to any one who should construct a new machine for carding cotton. The carding machine then in use could not be employed to prepare cotton like wool, and, besides this, its use was attended by considerable waste. Heilmann resolved to compete for the prize. This, however, was not the beginning of his labors; for, after directing a work-shop for the manufacture of machines, he had successively invented a curious machine for embroidering, in which twenty needles worked at the same time, an improved loom, a machine for measuring and folding cloths, and another to roll warp. His loom for weaving two pieces of velvet at once had attracted particular attention. But the new problem to which he addressed himself was much more difficult than he had anticipated. He was obliged to devote several years to the study of the subject; and the more distant the goal, the more obstinately he strove to reach it. It became necessary to undertake costly experiments, to construct experimental apparatus, and to renew his attempts over and over again. He at length became involved in such great expenses that his entire fortune, including his wife's dowry, was absorbed by the costs of his works of research. Soon reduced to poverty, he saw himself under the cruel necessity of borrowing wherewith to live from some of his friends In the meantime, having lost his wife, the unfortunate experimenter resolved to leave his country and go to England, and seek a profession that would allow him to support his two daughters. He went to Manchester, the idea of his combing machine ever pursuing him and filling his thoughts. He constructed a model of it for an English manufacturer, but his hopes were again deceived. He returned to France to visit his family, never ceasing, wherever he might be, to think about the solution of the problem which pursued him as a fixed idea. While sitting one day at his fireside meditating over the sad destiny of inventors, he caught himself in the act, although scarcely conscious of it, of very attentively observing his daughters combing each other's hair, and who deftly drew the comb through their long tresses without the least difficulty. "If," thought he, "I could successfully imitate in a machine that way of drawing out long fibers and carrying back the short ones by the opposite action of the comb, it might really get me out of my trouble."

He again set himself to work, and after more than seven years of efforts, he finally invented the carding machine, which, although simple in appearance, is in reality very complex. It took him several years more to arrive at his final model, but this once attained it was so perfect that there is scarcely any hope of surpassing it. To appreciate this marvelous machine and to recognize the analogy that exists between its mechanism and the action that gave birth to the idea of it, it must be seen at work. To use the expression of an eminent English engineer, the Heilmann machine works "with a delicacy of touch almost comparable with that of the human fingers." It combs the flock of cotton from the two ends, places the filaments perfectly parallel to each other, picks out the long threads, which it separates from the short ones, and unites the one and the other in distinct bundles. The Manchester spinners soon comprehended the merits and advantages of the new machine, and one of the principal ones among them having adopted it, six other manufacturers clubbed together and bought the privilege of using it for $150,000. The wool spinners gave the same sum to apply it in their industry, and the manufacturers of Leeds paid $100,000 for the right to use it in dressing flax. Joshua Heilmann saw riches flowing into his pockets, but it profited him nothing, for he died at the moment when success was coming to crown his long labors so brilliantly. His son, who had shared his poverty and his convictions, soon followed him to the grave.

PROGRESS OF SHIP BUILDING.

THE opening meeting of the Graduates' Section of the Institution of Engineers and Shipbuilders in Scotland was held lately, Mr. JOHN F. MILLER, president, in the chair. After the transaction of some general business, Mr. Miller proceeded to deliver his presidential address.

He said that in some respects the progress made during the past year was far beyond what any one could almost have imagined. Perhaps the most interesting subject, and one which had engaged a great deal of attention in the Glasgow district, was that of "steel *versus* iron," not only for shipbuilding, but for almost everything. This time last year steel for shipbuilding and boilermaking was almost novel, and it was only manufactured in Scotland for such purposes at the works of the Steel Company of Scotland, at Newton, near Glasgow, and which works were even at that time very largely engaged in the manufacture of steel rails, although they had various contracts with shipbuilders for plates, angles, beams, etc. The rolling of steel rails, however, had now become so scientific as a matter of practical work, and moreover the price for such material had been so far reduced, that, unless in the most recently fitted-up establishments—and even then only in those that had been fitted up for such work—could steel rails be produced as a financial success. It therefore became a matter of consideration with the Steel Company of Scotland whether they should not give up that class of work, and in the meantime go into what they were now almost exclusively doing, namely, the manufacture of soft steel for the production of plates, angles, beams, and bars. From their returns last year it had been found much better for their interest to keep their works going on that branch of manufacture; and as affairs were evidently turning, it was a good thing for the neighborhood. In the meantime there was no doubt that the Steel Company stood second to none in the manufacture of soft steel for ship and boiler purposes, and the confidence in their material had gone a very long way to induce the shipowning public to see it to be to their advantage to use it in building their vessels. In a country of progress and advancement like this it could not long remain a secret to say how steel was made, more especially when many large and wealthy ironmasters found their trade leaving them, and their works almost at a standstill for months. Under such circumstances they naturally turned their attention to the comparatively new industry, and thus it was not astonishing to find another large establishment following in the wake of the Steel Company of Scotland and starting in the same manufacture. He referred to Parkhead Forge and Rolling Mills, Glasgow, a considerable portion of which had been adapted by Messrs. Beardmore to the production of steel of the same quality as that manufactured by the Steel Company, the Siemens-Martin process being used in both cases. Having given a description of the steel department of Parkhead Forge, somewhat similar to that which appeared in a recent issue of the *Colliery Guardian*, Mr. Miller went on to say that that alteration for steel-making was certainly an advance in the right direction, for in no business was it proper for any individual firm to have a complete monopoly. In that respect it had been acknowledged that the Steel Company had had everything their own way far too long; he therefore wished all success to the new works for steel making, such success as the proprietors had hitherto enjoyed in their iron department. Proceeding to refer to the rapid increase in the adoption of steel in shipbuilding on the Clyde, he said it was only necessary to look back about twelve months in order to see what a very large proportion of vessels were now built of steel as against iron in former years, while about two years ago comparatively few vessels had been built of that material, and even then there was very great suspicion as to their lasting power, and the suitability of the new material for such a purpose. During the present year many of the shipbuilding yards on the Clyde might be found almost wholly employed in the building of steel vessels, and there were very few yards indeed that had not been doing something in that way. He might mention that one yard had, up to the present time, turned out something like eleven steel built vessels this year, varying in size from a few tons to about 4,000 tons gross register tonnage, and varying in construction from yachts and fast light-draught steamers to ocean traders. It was only a month or so since the largest steel vessel afloat was launched at Dumbarton for Messrs. J. and A. Allan; and when that vessel was contracted for there was naturally considerable discussion as to the advisability of taking such a step. As an indication that Messrs Allan were not far wrong in the resolution come to, it was found that a large number of other shipowners were following their example. That number was certain to increase unless steel manufacturers raised

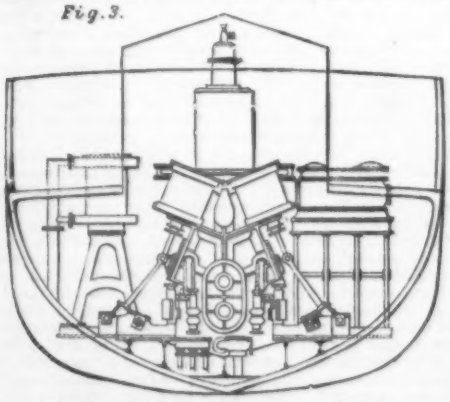
their prices to such an extent as would render the first cost of vessels so much greater than that of iron-built vessels that the extra carrying power in the case of the former would not compensate for the difference. As a further instance of the still growing confidence in steel he referred to the fact that orders for two very large vessels had just been placed with shipbuilding firms on the Clyde—one for the Cunard Company and the other for Messrs. Allan. Besides being built of steel, it was stated that the Cunard liner when launched would be the largest vessel afloat except the Great Eastern, and probably the fastest ship crossing the Atlantic. She was intended to be a vessel of 7,500 tons, with a horse power of 10,000; length, 500 ft.; breadth of beam, 50 ft., and depth of hold, 41 ft.; the propelling machinery being a set of three-cylinder, direct-acting, inverted compound engines, supplied with steam from seven boilers. Besides having such enormous size and power, she was to be somewhat novel as to her construction, having water ballast tanks to hold about 1,000 tons of water, and to have a carrying capacity of 6,500 tons, and bunkers sufficient to contain 1,700 tons of coal; while not the least interesting feature would be her passenger accommodation, being fitted for 450 first-class and 600 steerage passengers, and requiring a crew of 200 men. The mode of construction to be adopted was that known as the "longitudinal and bracket" system, a system of shipbuilding very much under discussion at present, although it had been in use for some considerable time, and within a short period very much improved. This vessel had to be built and launched and got ready for sea in seventeen months. That looked like a long time, but when one took into consideration the immense amount of material that had to be put together it was certainly not too long. Messrs. Allan's new steamer was not to be so large as the Cunard liner, although a few years ago she would have been regarded as something extraordinary, being a vessel of 5,500 tons, 440 ft. long, with a beam of 46 ft., and depth of 36 ft. Her engines, like most of the very large ones now made, were to be of the compound three-cylinder type. Her saloon was to be amidships, and suitable for 200 passengers, while her accommodation in the steerage was intended for about 1,000 persons. There were also to be water ballast tanks, giving, as it were, a double bottom, which would afford some security in the case of the vessel running aground.

Before leaving the subject of the manufacture and application of steel, Mr. Miller referred to the progress at present being made in the way of increasing the making power at the works of the Steel Company of Scotland. These works, although already of huge proportions, were still increasing, there being at present in course of construction three large engines and two sets of rolling mills, so as to enable the company to meet the fast increasing demand for their material. With these additional mills for plates, angles, and bars they trusted to be in a position to avoid the great inconvenience which nearly all consumers had experienced through the great delay in getting delivery of the material. Mr. Miller subsequently dealt with the subject of utilizing steel scrap, a question which excited much anxiety about a year ago. Of course the Steel Company were willing to take back the scrap, but at such a low price that to the seller it was of less value than scrap iron. The question had now, however, been solved, and in consequence there was quite a run after the material. Besides being found to be quite easily worked, and very suitable for small forgings, it had been taken up by a Coatbridge ironmaster, who found that he could work it up into rods almost as easily as scrap iron; but his experience showed him that it required a much higher heat to weld the pieces into a solid billet. In testing the rods (which Messrs. Denny had kindly done for Mr. Miller), it was found that while the average of the bars made by the Steel Company of Scotland stood a tensile strain of 28·3 tons per square inch, the rods made from the steel scrap only bore a strain of 26·6 tons per square inch, with an equal extension of 20 per cent. The bars made from the steel scrap were not, however, tested for their shearing strain; but he thought they would stand better than the Steel Company's bars. He had himself a series of tests of scrap steel bars in progress, but unfortunately they were not far enough worked out so as to be embodied in his opening address to the section. The great advantage in the scrap steel was its price, as it could be produced at about £2 per ton less than steel bars direct from the steel makers. As Lloyd's and the Board of Trade only required steel to stand a tensile strain of from 24 to 26 tons per square inch, welding up and working the scrap steel into bars would, he thought, prove a decided success.

After giving a somewhat detailed description of the extraordinary vessel which Messrs. Elder & Co. have recently contracted to build in the shape of a yacht for the Emperor of Russia—330 ft. long by 153 ft. wide, and required to steam at the rate of fourteen knots—which he characterized as a wonderful piece of naval architecture, a practical application of Admiral Popoff's idea, Mr. Miller proceeded to notice some recent works in civil engineering. Amongst them he included the Caledonian Railway Company's viaduct over the Clyde at Glasgow Harbor, and the Central Station to which it leads; the projected steel and iron bridge over the Forth at Queensferry; the railway bridge over the Severn; the tunnel under the river; the proposed tunnel under the Mersey from Liverpool to Birkenhead, and that which it is proposed to cut through Mont Blanc. Regarding several of those undertakings he mentioned some interesting particulars, coupled with a few critical remarks.

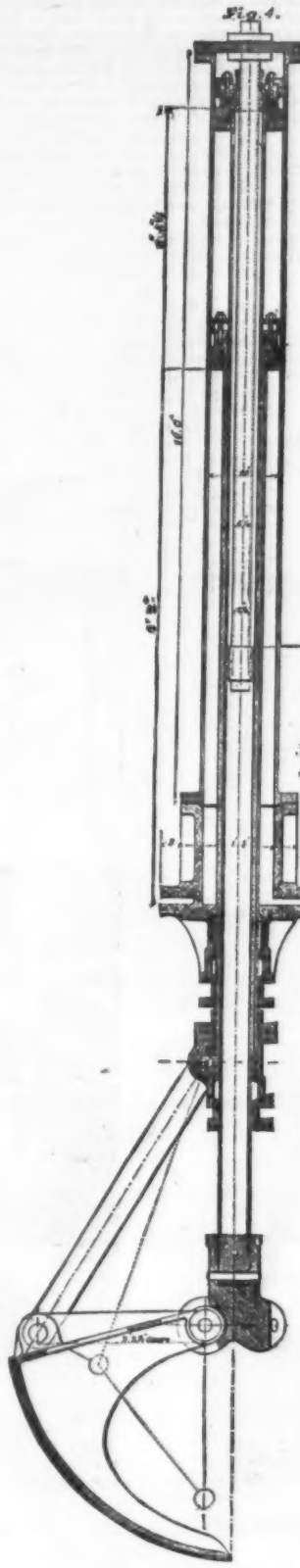
COMBINED DREDGER, TUG, AND FIRE ENGINE.

Fig. 3.



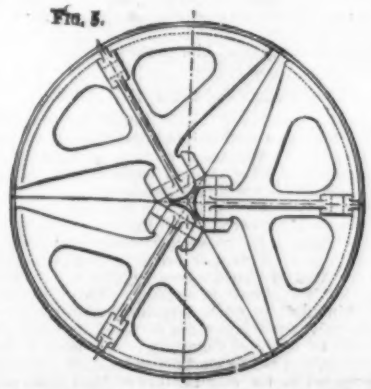
For description see SUPPLEMENT, page 3244.

Fig. 4.



COMBINED DREDGER, TUG, AND FIRE ENGINE.
For description see SUPPLEMENT, page 3244.

FIG. 5.



COMBINED DREDGER, TUG, AND FIRE ENGINE.
For description see SUPPLEMENT, page 3244.

HYDRAULIC ENGINEERING.*

Sea-Wall. A revetment along a line of coast, or the bank of a watercourse.

A sea-wall may form one or more sides of a harbor, as in the case of the Heptastadium of Alexandria, the moles of the Pireus and Rhodes, of Civita Vecchia, Ostia, and Antium, as well as those of many modern ports, especially in Europe, whose small rivers afford but narrow refuges.

The Roman embankments of Essex and Lincolnshire, in England, were steep mounds of earth, defended by rows of piles, the intervals between the rows being filled up with chalk.

Modern embankments on the estuary of the Thames consist of three strata. The rise of tide is 10 feet, and the lower or main portion of the work is made with a base of 5 to 1 vertical. The top width of this portion is 20 feet, and on it rests the *outburst* bank, 5 feet high and 8 feet wide at top; having a slope of 1½ to 1; thirdly, the *wash* bank, 2½ feet high, and the same width at top.

The embankments are *pitched* with stone on a solid facing of clay, in positions much exposed, while in others the surface is covered with clay and gravel where it is washed by the water, the upper slope being turfed or protected by a growth of couch grass, ray grass, or lucerne.

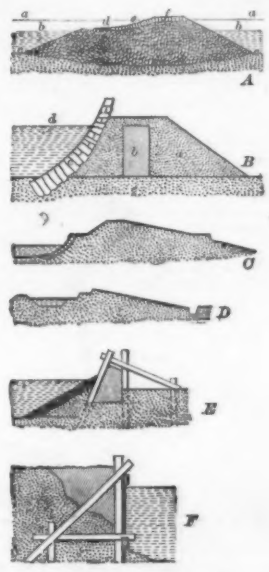
Shore defenses are of four kinds:

1. Artificial constructions which break the force of the waves before they reach the shore.
2. Those which consolidate and elevate the shore itself, so as to enable it to resist the action of the waves.
3. Those which make or assist the accumulation of sand or shingle upon the shore.
4. Permanent breakwaters, which act as islands in the offing and exclude the waves.

Of the first description were the cones of Cessart, placed off Cherbourg. Being destroyed, a breakwater of coursed masonry on a bank of *pierre perdue* was substituted.

Of the same description also are the moored crates of timber, through whose interstices the water passes, the timbers breaking the force of the waves. See Breakwater.

Of the second description are the dikes of Holland and of France. These are *sea-walls*, and belong to this article.



A, Plymouth breakwater. B, Sea-Dike with facing wall and core. C, D, Inclosure of Zuid Plas, near Rotterdam, Holland. E, Polder bank, Holland. F, Havre sea-wall.

FIG. 1.—SEA WALLS.

Of the third description are groins or timber erections, which are common on the sandy coasts of England and France. See Groin.

The works of Brémontier in the Landes of Bordeaux are also of this character, though they are rather those of the planter than the constructor. His devices were eminently worthy of the engineer on the principle of Leupold's maxim: "Artis est naturam imitare."

Of the fourth description are the solid breakwaters of Plymouth, Cherbourg, Cette, at the mouth of the Delaware, Buffalo, and elsewhere.

Sea-walls are made in many places to protect harbors or to save the land from encroachment. When faced with coursed masonry, they may have the form shown at B.

a, is an earthen embankment; *b*, a solid wall or core of puddle; *c*, a facing-wall of masonry; *d*, the high-water level of the sea or bay; and *e*, the natural bed. The form of the front wall must be adapted to resist the action of the waves, and the embankment must have an internal slope, according to the nature of the materials of which it is composed; for ordinary materials, a base of 1½ to a perpendicular height of 1 will insure the necessary stability and firmness.

If the entire embankment be formed of loose stones, with occasional facing only of laid masonry, as in the case of the celebrated breakwater at Plymouth, a form of less steepness must be adopted for the sea-face of the embankment.

A, Fig. 1, is a section of the Plymouth (England) breakwater. The line, *a a*, shows the level of high-water spring-tides; *b b*, low-water spring-tides; *c c*, original bottom, varying from 40 to 45 feet below low-water mark; *d*, the foreshore; *e*, sea-slope; *f*, top, 45 feet wide. The mass of the work is composed of limestone, from the Overton quarries, distant 4 miles from the spot. The stone is raised in blocks varying from ¼ to 10 tons and upward in weight, which are promiscuously thrown into the sea, care being taken that the greater number of the large blocks are thrown upon the outer or sea slope, and that the whole are so mixed together as to render the mass as solid as possible, the rubbish of the quarry and screenings of lime being flung in occasionally to assist the consolidation of the materials. The form of the outer slope, below low-water line, has been effected by the action of the sea, and is ascertained to be at from 3 to 4 feet of base to 1 of perpendicular altitude. From low water upward the work has been set artificially and inclined at 5 to 1. The inner slope next the land is nearly 2 feet base to 1 altitude. The foreshore, shown at *d*, which is

* From Knight's Mechanical Dictionary. H. O. Houghton & Co., publishers, New York and Boston.

from 30 to 70 feet wide at different parts of the work, rises from the toe of the slope to a height of 5 feet above low water at its outer extremity, and serves to break the waves before they reach the main work; thus diminishing their force, and, at the same time, preventing the recoil of the wave from undermining the base of the slope.

No other country in the world has so stern a contest to wage with the waters for its existence as Holland. Many thousands of square miles of tillable land have been reclaimed, and are only maintained by vigilance in the preservation of the *dunes* or banks of sand which oppose the waters of the ocean and the large estuaries and rivers of the country. The conformation of these is indicated by the illustrations, one of which (D) shows a sea-wall, and the other (C) one of the subordinate embankments, whereby the interior water-courses are lifted above the level of the country they traverse.

The materials of the Dutch sea-walls or *dikes* vary with the facilities, situation, materials, exposure, slope, etc.

Piling; double sheet-piling, with interposed puddle or rubble; earthen embankments, with or without walls of puddle, to render them water-proof; bundles of reeds, fascines, or gabions, laid in cross tiers with strata of soil, and secured by stakes or masonry.

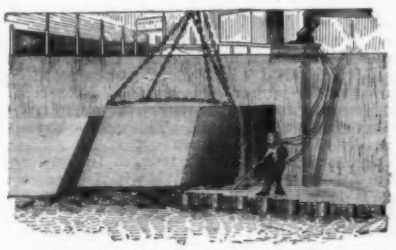
Another form of sea-wall, F, is extensively used in the banks of the polders of Holland. It consists of a double row of sheet-piling inclosing a *puddle dike* of retentive soil. The foot is protected by an apron of rubble.

At Havre an embankment of earthwork is formed behind a vertical inclosure of sheet-piling, as shown at F. The piles of the face are fastened by diagonal ties to the rear row of piles. The foot is protected by rubble or coursed masonry, according to the character of the ground, the exposure to currents, etc.

In Fig. 2, A B illustrates the sea-wall now being built along the water-front of New York City. Beyond this piers will project into the stream. In the execution of the work the old wooden docks are removed, and the bed of the river

FIG. 2.

Fig. 4801.



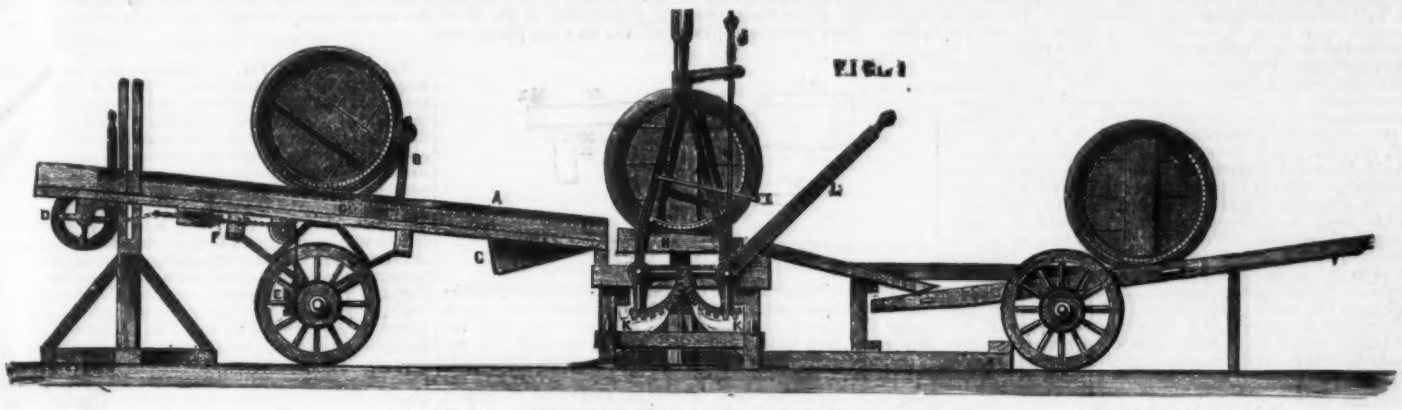
SEA WALL.

dredged until solid bottom is reached. Piles are then driven, for the width of 27 feet, sawed off to a uniform depth below low water, and the interstices between them filled up to within two feet of their tops with stones thrown over from barges. Upon this a layer of concrete is spread by divers to the level of the tops of the piles. The concrete is composed of 1 part of Portland cement, 2 sand, 4 crushed stone; and, when it has set, blocks of the same are laid upon it to form the wall. These blocks are moulded; the larger blocks designed for the front of the wall average 36 tons in weight, and batter 2½ inches to the foot on the outer or water side; square, smaller blocks are used for backing. The upper part of the wall has a granite coping whose exposed portions are dressed.

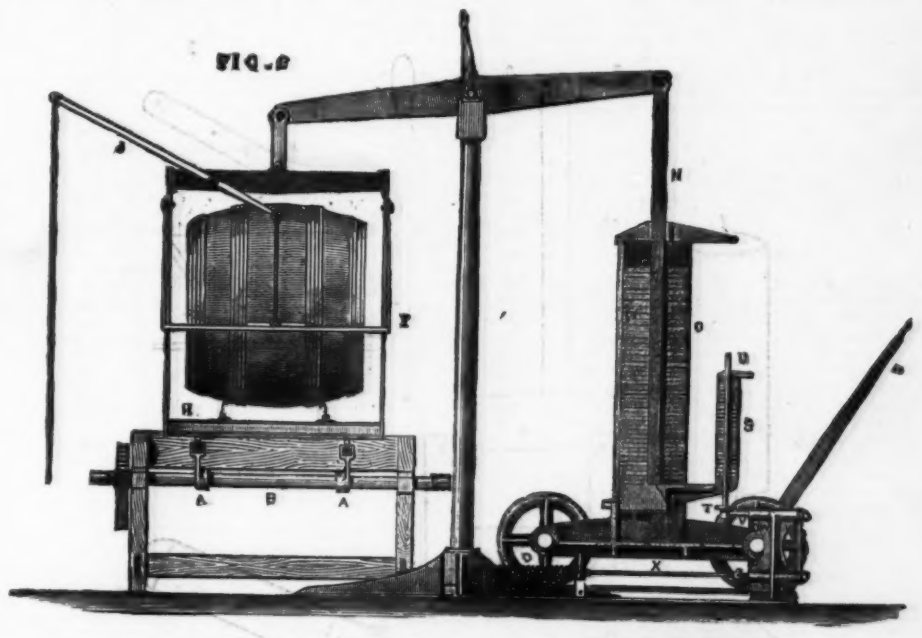
The sides of the large concrete blocks are grooved to receive a chain by which it is lowered from a derrick; the *setting* is done by divers. The wall extends into the river to various distances—at Christopher Street 250 feet—beyond the present front; the intermediate space will be filled in with rubbish and paved. The work, when completed, is designed to extend around nearly the whole circumference of Manhattan Island. At present (November, 1874) operations are in progress at the Battery, at the foot of Canal Street, and at the foot of Christopher Street; all on the North River side.

AUTOMATIC WEIGHING APPARATUS.

In this machine, invented by Mr. James Craig, of Greenock, it is claimed, are combined the labor-saving advantages of the steelyard and the self-acting principle of the spring balance, inasmuch as no weights require to be handled, the scale and weights being so constructed that the weight of the package causes the weight scale to lift the exact quantity of weights required to balance the beam; in addition it has this great advantage, that the weights used are all of Board of Trade standard denominations with an even beam. The complete apparatus as shown in the drawings is specially designed for weighing hogsheads or other similarly shaped packages, but with slight modifications it is equally suitable for weighing packages or goods of any form or size. Fig. 1 is a side elevation. The hogshead is

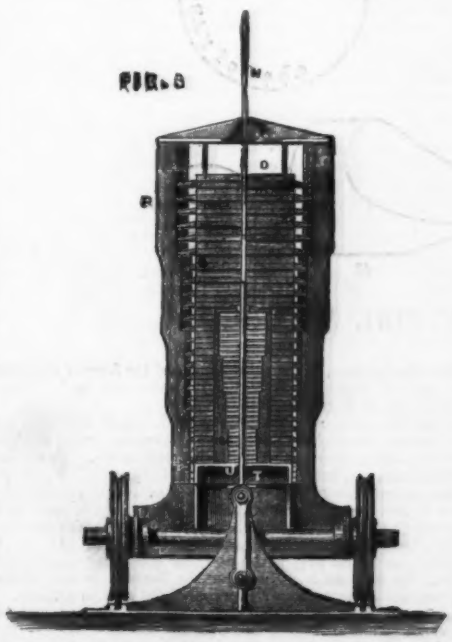


CRAIG'S AUTOMATIC WEIGHING MACHINE.



CRAIG'S AUTOMATIC WEIGHING MACHINE.

received at the higher end of a platform or plane, so inclined that it rolls on the platform by its own gravitation. To facilitate the rolling a pair of parallel iron rails, A of box hol-



CRAIG'S AUTOMATIC WEIGHING MACHINE.

descent on to the cart or lorry laced in position to receive it. The scale is suspended from the end of the beam in the usual manner, but when the cask comes on to it, it is also supported from below by four cams on a pair of parallel shafts connected by toothed quadrants, K, worked by the lever, L. By raising this lever the cams are lowered, and the entire weight of scale and package left on the end of the beam. This arrangement serves the double purpose of preventing any unnecessary jerking or wear on the knife edges of the beam, and by letting the weight come gradually on to the beam the weights are lifted one by one by the weight scale, M. In Fig. 2 so much of an end elevation is given as will explain the action of weighing. The beam is of the ordinary description, and may be either supported on a stand or suspended as in the common hanging beam. The scale, M, is connected to the beam by a flat iron rod, N, and receives the weights, O, which are thin square blocks with slots to enable their being centrally placed on the scale, the suspension rod fitting into the slots. The weights while on the scale and in their frame are always in the same order, one being directly over another. A pair of studs project on opposite sides, by which the weights are supported while in the frame, P. This frame is box-shaped, open towards the scale, and has on the opposite inside several series of steps so arranged that all the weights can be supported in it by their studs each independently of the other with a clear space between them. Fig. 3 is a side elevation of the frame showing the stepping, and Fig. 2 shows a part elevation. The frame is mounted on a carriage with four wheels, and by turning the lever, R, the frame may be taken inward clear of the scale, or outward so as to inclose it. In this position the scale, M, is directly under the lowest weight in the frame, the suspension rod close in to the back part of the slots. When the package to be weighed is on to the scale, H, and the lever, L, raised up—the scale gradually falling down as the cams which support it are withdrawn—the weight scale, M, rises, and as it does so lifts one by one the weights off the frame until it has lifted sufficient to counterbalance the package. The lever, R, is then turned inward till the frame is clear of the scale. Should the package weigh an exact number of the weights in the large frame, which may be of any denomination—56 lb. or 28 lb.—then the weight has only to be recorded and the frame returned, so as to inclose the scale

again. If, on the other hand, small weights—say 1 lb. weight—are required to make the exact weight, the weight scale will always take off the frame the weight that checked it from rising higher. There is now too much weight on the scale, and it consequently tends downwards. This downward motion gives the means for working the small weights. These are arranged in a frame, *s*, similar in every respect, except size, to the large one already described. It is supported on the scale, M, of which it forms part. When the scale descends, the superfluous small weights are caught one by one by the disk, T, which is then directly under them, a rod, U, working in their slots. When the scale has gone down until only the exact weight required to balance the package is left on, a further turn of the lever, R, takes the disk, T, into the position shown in the drawing. The disk is supported on a slide, V, working in a stand, W, and connected to the weight frame by a rod, X. This connection is so arranged that when the frame is just moved inward clear of the scale, a further turn of the lever, R, pushes the connecting-rod, X, outward, and consequently the disk, and whatever small weights that may be on it, clear of the scale. On the weight being recorded, the frame, P, is moved outward, the disk, T—by the action of a spring—goes inward, the scale lever, L, is lowered, and the weights return to their particular positions in the frames ready for the next package. To save counting the weights and also to insure accuracy the large weights are numbered progressively, beginning at the lowermost, the small ones beginning at the uppermost, so that by merely looking at the weights the total weight on the scale at any time is obtained. The whole process is almost instantaneous. A hogshead of sugar weighing a ton may be rolled from a ship's side to the scale inside a shed, the weight of it ascertained to a pound, and then loaded on to a car without almost any labor, the two attendants being merely required to work a few levers.—*The Engineer.*

ROMAN CANDLES.*

TO MAKE A ½ ROMAN CANDLE.

PROCURE a straight piece of brass tube, $\frac{5}{8}$ of an inch external diameter, and 16½ inches long. Saw or file off a piece, 1½ inch long, Fig. 1. This is for the star former, and is drawn of the correct size.

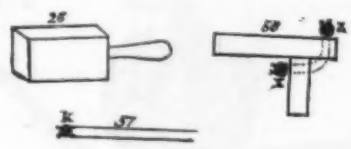
In the other piece, of 15 inches, fix a handle, as shown, in diminutive, in Fig. 7. This is for the case former. It should be filed smooth at the end.

Take another piece of brass tube $\frac{5}{8}$ of an inch external diameter, and about 16½ inches long. In this also fix a handle, or fix it into a handle, Fig. 4. Invert it, and set it upright in a flower-pot, filled with sand or loose mould. Melt some lead in a ladle, and pour it slowly into the tube, leaving room for the air to escape up the side, till it is full. If the lead is poured in rapidly, the confined air, expanding, jerks the metal up, and may cause serious injury. A pound or more of lead will be required. When cold, drive the end of the lead in with a hammer, and file in smooth. This is for a rammer.

Take a piece of deal, Fig. 6, about 12 inches long, 6 broad, and ¾ thick; and, on the top, screw a handle, like one on a scrubbing brush. This is for a rolling-board. An iron door-handle would answer. A wooden one, however, about an inch thick, not cylindrical, but slightly flat, and rounded at the edges, is preferable, as it gives more purchase for the hand.

Cut a piece of tin, or zinc, or thin board, into the shape of Fig. 8, in which the distance between the arms, *a* and *b*, across the dotted line, shall be $\frac{5}{8}$ of an inch. This is for a gauge, with which to measure the external diameter of the case. Write upon it, "⅝ space."

Procure some 60 lb., 70 lb., or 84 lb. imperial brown paper: the size of a sheet will be 29 inches by 22½. Cut a sheet into four equal parts, each 14½ by 11¼: paste the four pieces on one side, and lay them one on another, with the pasted face upwards, putting the fourth piece with the pasted side downwards, upon the pasted side of the third piece. Turn them over; take off the now top piece, and



MANUFACTURE OF FIRE WORKS.

lay it flat on the near edge of a table, pasted side upwards. Take the former, Fig. 7, and paste the tube all over. Lay it along the edge of the paper, bend the paper over with the fingers of both hands, and roll it tightly up, until the external diameter of the case about fits the gauge, Fig. 8. If the paper should be too long, of course a piece must be cut off; if it should not be long enough, more must be added, taking care to bind in the second piece with three or four inches of the first piece; for if the whole of the first piece be rolled up before beginning the second, the latter, when dry, will probably slip off, and spoil the case. The case having been rolled up, take the handle of the former in the left hand, lay the case flat on the near side of the table, take the rolling-board, Fig. 6, in the right hand, press the front part of it on the case, and drive it forward five or six times, like a jack-plane, letting the handle of the former slip round in the left hand. This will tighten the case, and render it, when dry, as hard as a book-cover.

The former must always be pasted, before rolling a case, to prevent its sticking. It should, likewise, be wiped clean with a damp sponge, before being laid aside. Brass tubes keep clean a much longer time if lacquered. To lacquer them, clean them with very fine glass paper; make them hot by the fire, till you can just bear them on the back of the hand; then, with a camel's-hair pencil, wash them over with thin lac solution. The cases may be either 14½ or 11¼ inches long; but 11¼ is the best, for when the cases are too long, the fuse as it approaches the bottom, is apt, if slow, to smoke; if fierce, to set the top of the case in a flame. If the learner decides upon 11¼ inches, the former and rammer may each be two or three inches shorter.

After the first case has been rolled up to fit the gauge, it may be unrolled, and the paper measured. Future pieces of the same quire of paper can then be cut of the right size at once, so that the case will fit the gauge without further trouble.

A large slab of slate is convenient for rolling upon; but a smoothly planed board will answer every purpose.

When a number of cases are finished, bitch a piece of flax two or three times round each of them, and hang them up to dry in a place free from draught, that they may not warp.

Flax is sold in balls; the thick yellow is the best. It is named, indifferently, flax or hemp. It is much used by shoemakers, and is sold at the leather shops. Two or three thicknesses of this, waxed, or drawn through the hand with a little paste, is very convenient for passing round the necks of small choked cases, tying cases on wheels, etc.

TO MAKE A ROMAN CANDLE STAR.

Take the former, Fig. 1, which, as said before, is 1½ inch long; have a cylindrical piece of turned wood, box, beech, or mahogany, Fig. 2, about two inches long, and of a diameter to just fit easily into Fig 1. At a point, *a*, at the distance of about ¼ of an inch from the end, *d*, with a brad-awl, or very small gimlet, or nosebit, make a hole, and drive in a piece of brass wire, to project just so much as to prevent the tube slipping over it. A piece of a brass rivet, such as used by shoemakers, is convenient for the purpose. The part with the head on is best; a quarter of an inch length will be sufficient, filed or cut off with the nippers. It is evident that upon inserting Fig. 2 into the tube, Fig. 1, a vacant space of $\frac{5}{8}$ of an inch will be left at the bottom. Fig. 3 is a piece of turned wood, or, better still, of turned brass, exactly like Fig. 2 without the side-pin, *a*. Now, to pump a star, insert Fig. 2 in Fig. 1, press the tube into damped composition, turn it round and withdraw it. Rest the tube on a flat surface, insert Fig. 3, and give it two or three taps with a small mallet, like Fig. 26. A convenient size for the mallet is 1½ inch square, 3 inches long, with a turned handle. The mallet is best made of beech or mahogany. The slight malleting consolidates the star and prevents it from getting broken in charging, it will compress it to about nine-sixteenths of an inch in height. Push it out and set it by to dry.

Stars are best made in summer, and dried in the sunshine; when dry they should be put into clean pickle-bottles furnished with tight-fitting bungs. A piece of wash-leather passed over the bottom of the bung, gathered up round the sides, and tied at the top like a choke, makes a good stopper. Shot, shaken up in bottles, with water, soon cleans them.

TO DAMP STARS.

Stars containing nitrate of strontian must be damped either with lac solution or wax solution; anything containing water destroys the color. Niter stars may be damped with gum water, dextrine solution, or thin starch. Most other stars with either of the solutions. Crimsons and greens *will* mix with boiled linseed oil, but they cannot then be matched, as oil renders meal-powder almost unit flammable. With all stars, not a drop more of the solution should be used than is sufficient to make the composition bind; and it is advisable not to damp more than half an ounce at a time; this is particularly the case in using the lac solution, as it dries rapidly; and if a large quantity of composition is damped, and gets dry, and has to be damped over and over again, it becomes clogged with the shellac, and the color is deteriorated. If it should get dry, and require a second damping, it is best to use pure spirit only the second time.

Before mixing compositions, every article should be as fine as wheaten flour and perfectly dry. Nitrate of strontian, if purchased in the lump, should be set over the fire in a pipkin; it will soon begin to boil in its water of crystallization; it must be kept stirred with a piece of wood till the water is evaporated and a fine dry powder left. A pound of crystals will yield about eleven ounces of dry powder, which should be immediately bottled. Even then, if used in damp weather, it is best dried again and mixed with the other ingredients while warm. This second drying may be in a six-inch circular frying-pan.

Articles, separately, may be reduced to powder with the pestle in a mortar. See that it is wiped clean every time, as there is danger of ignition with chlorates and sulphurets. When the articles are to be mixed, they may be put into the mortar and stirred together with a small sash-tool. A ¾ inch is a convenient size. The mixture must then be put into a sieve and shaken in the usual way; or it may be brushed through with the sash-tool. Return it to the sieve and brush or shake through again. As it lies in a heap, level or smooth it with the blade of a table knife, or any straight-edge; if thoroughly mixed it will present a uniform color; if it appears darker in one part than in another it must be sifted again. A sieve with a top and receiver is very desirable, as nearly all mixtures are either black or poisonous; the dust from star mixtures is very injurious to the lungs. If a top and receiver cannot be readily purchased, both may easily be constructed out of a sheet of millboard, fastened with a brad-awl and waxed yellow flax, and neatly covered with paper.

Mixtures may be damped on a Dutch-tile, a marble slab, or a slate without a frame. They may be stirred about with a dessert knife, pressed flat, and chopped, or minced as it were, and again pressed flat.

TO MAKE LAC SOLUTION.

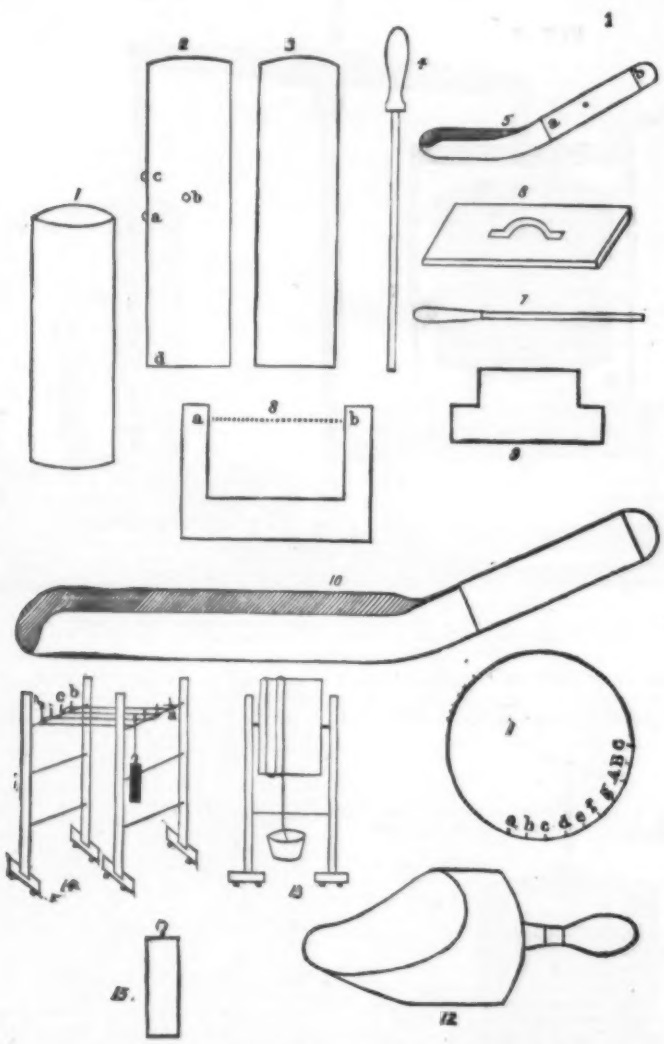
Put half an ounce of flake shellac into a tin pot, and pour upon it a quarter of a pint or five ounces of methylated spirit; or, preferably, a like quantity of wood naphtha. Let it stand for about a day, stirring it occasionally till dissolved. Then half fill a basin with boiling water; set the tin containing the lac in it and leave it till it boils and curdles. If the water does not remain hot long enough to make it boil, set it in a second basin of boiling water. As soon as it has curdled remove it, and when cold pour it into a vial and cork it. Spirit must never be boiled over a fire nor near one, as the vapor might inflame. Keep the pot, therefore, while in the hot water, at a distance from a fire or flame of a lamp or candle.

TO MAKE WAX SOLUTION.

Put into a vial half an ounce of white wax (bleached beeswax), pour upon it five ounces of mineral naphtha (coal or gas tar naphtha), keep it tightly corked.

TO MAKE STEARINE SOLUTION.

Dissolve a piece of composite candle in mineral naphtha in the same way. Mineral naphtha must not be used near a candle or fire, as it gives off an inflammable vapor at less than 100° Fahrenheit.



MANUFACTURE OF FIRE WORKS.

* From the *Pyrotechnist's Treasury.*

TO MAKE GUM SOLUTION.

There is no better way of preparing this than simply to put cold water upon gum arabic, and let it stand till dissolved. If for sticking purposes, as much water as will just cover the gum will be sufficient; but, for making quick-match, one ounce or 1¼ ounce of gum to a pint of water. If required in a hurry, put the gum into *cold* water, in a pipkin or tin saucepan, set it on the fire, make it boil, and keep stirring till dissolved. When cold, bottle and cork it.

TO MAKE DEXTRINE SOLUTION.

Take half an ounce of dextrine, and five ounces, or a quarter of a pint of cold water, put the dextrine into a cup or basin, add a little of the water, and mix it well with a teaspoon, rubbing it till all is dissolved; then add the remainder of the water, stir well together a second time, pour it into a vial and cork for use. Dextrine, wetted to the consistency of honey, may be used instead of thick gum-arabic water for pasting. For this purpose it is advisable to keep either in a wide-mouthed bottle, and to set the bottle in a gallipot containing a little water; the brush, a camel's-hair pencil, or very small sash tool with one-third of the bristles cut away on each side, to render it flat, can then be kept in the water when not in use; this will prevent it, on the one hand, from becoming dry and hard; and, on the other, from getting clogged and swollen. It can be squeezed between the thumb and fingers when wanted for use. The flat gum brushes now sold, bound with tin, are not pleasant to use, as the tin oxidizes and turns of a disagreeable brown color. If there is a difficulty in obtaining a graduated water measure, one sufficiently correct for pyrotechnic purposes may be made with a vial. Paste a narrow strip of paper up the outside of the vial, weigh four ounces of water in a cup in the scales; pour it into the vial, mark the height, and divide it into four equal parts for ounces; of course, it can be graduated into half and quarter ounces, and increased, if large enough, to five or more ounces. A gallon of distilled water weighs exactly ten pounds. Consequently a pint of pure water weighs a pound and a quarter. This is also near enough for spirit, though, of course, spirit is a trifle lighter. Doctors' vials are often marked with ounce divisions.

TO MAKE PASTE.

Paste is most economically made in a zinc pot, which may be four inches deep and three and a half inches diameter. Any zinc worker will make one to order. Put into it two ounces of wheaten flour, add a little cold water, rub the two together with a spoon till smooth and free from lumps; pour in more water till the pot is full within about an inch; set the pot in half a saucepanful of water, put it on the fire; make the water boil, and keep it and the paste boiling for four or five minutes, stirring the paste the while. Remove it from the fire, and set it by to cool. The paste is to remain in the zinc pot, in which it will keep good for a length of time and beautifully white.

Some recommend alum in paste; I think it best avoided, especially in cases intended to receive colored fires. Alum is a double salt, a sulphate of alumina and potassa; it has an acid reaction; and, coming in contact with chlorate of potash and sulphur, may cause spontaneous combustion. A drop of sulphuric acid instantly ignites stars containing them. At theaters the clown sometimes fires a cannon with what appears to be a red-hot poker; but which in reality is only a piece of wood painted red. A mixture is made of chlorate of potash and sulphur or sugar, a glass bead is filled with sulphuric acid, and the hole stopped up with wax. This is laid in the mixture, and when it is struck with the poker, the liquor escapes and inflames the potash and sulphur. Sulphate of copper is a particularly dangerous salt, and must never be used, as it is almost certain to cause spontaneous combustion. Chertier, to whom pyrotechny otherwise owes so much, introduced an empirical preparation, by dissolving sulphate of copper in water, together with chlorate of potash, drying it, and wetting it with ammonia; but this, however dried, when again wetted, turns litmus paper red. Practicus has named it Chertier's copper. I discommend its use.

Two paste brushes will be sufficient for an amateur, sash-tools, one about an inch diameter, the other smaller for light purposes. Let them stand in the paste. If they get dry the bristles fall out. For convenience, one may be kept in the paste and one in water.

Dry clay, powdered and sifted as fine as possible, is used for plugging or stopping up the bottoms of cases. I have for some time discontinued its use, and employ plaster of Paris in preference. Directions will be given for each, so that the learner can adopt which he pleases; but plaster is infinitely preferable. It is an American improvement.

ROMAN CANDLE SCOOPS.

No species of fireworks require greater care in their construction than Roman candles. In the first place the stars must be fierce, that they may light thoroughly; next, they must not be driven out with too great velocity. For this purpose the blowing-powder must be carefully adjusted. The stars also must be of so easy a fit that when put into the case they may fall to the proper depth of their own accord. If they require pushing, they are too tight, and will probably be blown out blind. When made as directed they will necessarily be of an easy fit, as they will be of the inner diameter of the brass tube, while the bore of the case is equal to its external diameter.

To regulate the blowing powder, prepare a number of little scoops, like Fig. 5, which is about the right size for the bottom star. They are formed of pieces of tin, zinc, or copper. Cut a long strip of tin, half an inch broad; cut this across into seven pieces of the following lengths: 1⅝, 1¾, 1⅞, 2, 2⅛, 2¼, and four inches. Round off the corners. Take a piece of brass wire, or stair-rod, about a quarter inch diameter, and with the wooden mallet before mentioned, Fig. 26, bend each of the pieces round the rod, into a half cylinder or gutter. Take up the smallest, and hold five-eighths of an inch of the end of the stair-rod in the end of the semicylinder to keep it open; put the other part from *a* to *b*, Fig. 5, in a vise and pinch it up; it will assume the form represented; the bowl part will be five-eighths long and the handle one inch long. Make the bowl of the next scoop six-eighths of an inch long, the next seven-eighths, and so on; the handle will always be one inch long. The last, for the top star, will have a bowl of three inches. The smallest scoop ought to hold as much grain powder as will weigh about one-twelfth of the star; but to have the scoops accurate, it will be necessary to charge a Roman candle, fire it, and observe whether the stars go a uniform height. For measuring the interval fuse, or fuse between the top of one star and the bottom of the next, a large scoop of the size of Fig. 10 will be required. The tin may be an inch broad, and the bowl part two and a half inches long, bent round the rammer, Fig. 4. To adjust it, take a Roman candle case, fit on the foot, Fig. 9, which is a piece of wood or brass turned with a tenon to fit tight at the bottom of the case. Fill the scoop, and strike it level with a straight-edge; empty it into the case, rest the foot on a flat surface; insert the rammer, Fig. 4, and jolt it up and down a dozen times or more, lifting it about half an inch at a time; put in another scoopful and jolt it in like manner. If the two scoopfuls thus compressed fill an inch of the case the scoop will be correct. If more or less, the scoop must be shortened or lengthened accordingly.

A piece of writing paper may be pasted and wound twice round the handle of each scoop, as from *a* to *b*, Fig. 4. One dot can be put upon the scoop for the first or bottom star; two dots for the second scoop, etc., or any memorandum can be written upon them for future guidance. Should they get soiled, they may be cleaned with a soaped damp piece of sponge.

Gunpowder for fireworks is used in two forms, meal powder and grain powder. Meal powder is a fine black dust and is employed in all cases of mixing. Grain powder is of three kinds, F, FF, and FFF—fine, double fine, and treble fine. FFF is best for crackers, simply because it runs rapidly down the pipes; for driving stars, shells, etc., F will be sufficient, but FFF may be employed; FF need not be purchased. If in any place there should be a difficulty in obtaining meal powder, F grain powder may be crushed in a leather bag by laying the bag on a hard surface and beating it with a hammer. The leather should be of the same kind as shoes are made of.

TO CHARGE ROMAN CANDLE CASES.

Pour some F grain powder into a wooden bowl or platter, represented by Fig. 11. Round the edge lay the little blowing powder scoops side by side, beginning with the smallest at *a*, the next at *b*, and so on to *g*. Put some Roman candle fuse into a large tin scoop, made to stand on a flat bottom, like Fig. 12, the same in shape as used by tea dealers; and, on the right-hand of it, lay the charging fuse scoop, Fig. 10. If the Roman candle is to contain different colored stars, set seven in a row in the order desired. When the cases are intended to be fired in threes or fours, the stars in one may be all blue, in another crimson, in another green, in another white. Fit the foot, Fig. 9, in the bottom of the case, put in a scoopful of clay, insert the rammer, Fig. 4, and jolt it till the clay is well compressed. The clay should fill half an inch. This being done, invert it, and shake out any little dust that may remain. Put in the little scoopful, *a*, of F grain powder, then lay the scoop at A. Now put in a star. As previously stated, it ought to fall of its own accord; but make sure that it has reached the blowing powder by putting in the rammer. Having ascertained this, put in a scoop of fuse, Fig. 10; lay the scoop on the right of Fig. 12; insert the rammer and jolt it; put in another scoop of fuse, Fig. 10; lay the scoop on the right of Fig. 12; insert the rammer and jolt it as before. Then proceed with the scoop, *b*, of grain powder and lay it at B, and so on, till the case is filled. The fuse on the top star is best driven in with a short solid rammer and mallet, as it is difficult to jolt the long rammer in so small a space. The last eighth of an inch, near the mouth of the case, should be fine meal powder, as it binds better than the Roman candle fuse, and also blows off the leader pipe.

The blowing powder scoops, having been laid at A, B, etc., all that is required is to turn the bowl or platter a little round to the left, and they will come in rotation ready for the next case. Also, by putting the scoop, Fig. 10, alternately to the left and right of the scoop, Fig. 12, it will always be known whether the proper quantity of fuse has been put in.

Colored stars, from their fierceness, have a tendency to burn in the cases. This defect may be remedied by putting upon each star a small scoopful of starting fire, No. 1, before putting in the interval fuse, as much as will fill round the sides of the star. This composition is somewhat fiercer than would suit for the regular fuse, so catches the blowing powder sooner.

A Roman candle is well charged when the stars isochronize, or come out at equal intervals of time; they should also, theoretically, ascend to equal heights; but, with colored stars this cannot be perfectly insured, as some shrink more than others in drying, and, of course, fit more loosely; some are heavier, some fiercer than others.

The interval fuse must always be driven in at twice, never at once. Each star, with its blowing powder and fuse, occupies about an inch and a half; perhaps a trifle more.

Instead of driving in clay at the bottom, plaster of Paris may be used, and then the foot, Fig. 9, will not be required. Have some plaster of Paris in a wide-mouthed bottle; a glass of cold water with a salt-spoon in it; and a number of pieces of paper, about four inches square. Put a small quantity of the plaster on one of the pieces of paper; indent the middle with the finger; put to it a little water, and work it up with a dessert-knife. Just as it gets to the consistency of mortar, and is about to set, mould it with the fingers to the shape of a cork; push it in to the end of the case; rest the case on a flat surface; insert the rammer, and give it two or three slight jolts; turn it round a few times and withdraw it. If the plaster sticks to the end of the rammer, it shows either that you have used the plaster too wet or have not turned the rammer round a sufficient number of times.

No more plaster must be mixed at a time than will suffice for one case. When plaster has once set it cannot be mixed up a second time; therefore take a fresh piece of paper, and let the knife be cleaned every time. It is advisable to have two dessert-knives, then one can be used with which to scrape the other. As much plaster should be used as will fill the case up about half an inch. They must be set by to dry; their not requiring the use of the foot will be found a great convenience.

Roman candles are usually made from three-eighths to six-eighths; but five-eighths is a very satisfactory size. If a Roman candle is intended to be fired singly, twist a piece of touchpaper round the mouth. If the cases are intended to be fired in threes, fours, etc., to form a bouquet, or to be placed round a mine, jack-in-the-box, or devil-among-the-tailors, omit the touchpaper, and envelop the case in double crown, made to project an inch beyond the mouth, to receive the leader or quickmatch.

A steel pen inserted, nib backwards, in the end of a small paper tube, rolled round the end of a penholder, makes a neat little scoop. It may be fastened in with a little plaster of Paris. A scoop may also be made with a quill.

Cracks in wooden bowls may be stopped with the same material; and, if painted over with linseed oil, after getting dry, will remain waterproof for a long time. A screw may be made to hold in brickwork, by drilling a hole in the brick and pushing in the screw covered with plaster.

TO MAKE TOUCHPAPER.

Dissolve half an ounce of niter in half a pint of hot water. Procure some 12 lb. double crown blue; cut each sheet into four equal parts, fifteen by ten. Lay them smooth upon each other, and, with a sash tool dipped into the niter solution, wash them over on one side, and hang them up to dry.

TO MAKE SLOWMATCH.

Dissolve one drachm of nitrate of lead in half an ounce of boiling water. Cut a sheet of blotting paper into six equal parts, and wet them on both sides, with a sash tool, with the solution. When dry, paste a piece all over, and upon it smoothly press another piece; upon this, pasted, put a third piece; and so on, till all the six form a stiff board. Lay them under a heavy weight; and, when dry, with a sharp knife and straight-edge, cut the whole into strips a quarter of an inch broad. Four inches will burn about a quarter of an hour. Narrow tape, boiled in the solution, makes excellent slowmatch.

TO MAKE QUICKMATCH.

Put into a pan one pound of grain powder or meal powder; pour upon it some thin hot starch and stir it well about, breaking all lumps till the mixture is of the consistency of paint. Procure some lamp cotton such as forms the wicks of candles. It will probably consist of sixteen or twenty-four strands. Divide it carefully into lengths of eight strands. This is not so easy a task as might appear. The best way is to act the reverse of a man spinning string. Divide the end of the cotton, say sixteen strands, into two of eight each; fasten them to two screw-hooks, a few inches apart. Take one in each hand and walk backwards, gently pulling them apart, and when they catch, untwist them; with care they will separate without breaking or entangling. Drop the end of one of the pieces into the pan; and, as it keeps falling, coil it round and round in the mixture, and press it down with an iron spoon until as much is pressed in as the quantity can saturate. Be very particular that it is thoroughly soaked. Have ready a wooden frame, Fig. 13, of deal, resembling a swing looking-glass with the glass taken out. It may be five feet by four. The frame is to be supported on pivots between two uprights. Fix a nail or hook at the left-hand corner of the frame, and tie the end of the cotton to it which has been hanging outside the pan. Get a person to slowly turn the frame and hold it steady. Take hold of the cotton in the right-hand, shut the hand, and allow the cotton to slip gradually and slowly through it as the frame is turned; squeeze it very gently, so as to allow it to come out well coated, and contrive to make it as round as possible. When all the cotton is wound upon the frame, spread some sheets of paper—old newspapers—on the floor; at each corner place a brick; lay the four corners of the frame upon the four bricks; sift dry meal powder all over the match, turn it over and sift over the other side. Prop the frame against the wall and leave it to dry. One ounce of white starch will be sufficient for a pint and a half of water. Rub the starch up smooth with a little of the water, then add the rest and boil it.

A NEW METHOD.

Put into a gallipot or basin some hot starch, made as before directed, or some cold gum-water, or cold dextrine solution; and with a small stencil brush, or a three-eighths sash tool, cut across the middle to make the bristles short and stubby, stir in some meal powder, till it is well mixed and looks like black paint. To avoid repetition, it will be convenient to refer to this under the name of meal paste. Take two towel-horses, Fig. 14, and set them parallel five, ten, or twenty feet apart. In the top rail of each drive four nails half an inch asunder. Fix the dry cotton to the nail, *a*, carry it across to the opposite nail, *b*, pass it round to the second nail, *c*, bring it to the opposite second nail, and so on, till the cotton lies in four parallel lines, like the strings of a harp placed horizontally. Hitch the cotton, without cutting it, to the hook of the weight, Fig. 15. This weight is made by taking a piece of brass tube one inch diameter and four inches long. Stop one end with a bung, fill it with melted lead; and before it sets push in a lucifer match, having previously cut off the priming. As soon as the lead is cold, pull out the match, which having been partially burnt smaller, will come out easily, and in the hole left by it screw a cup-hook as drawn. Invert the weight, pick out the bung, and fill its place with more melted lead. Now procure two pieces of planed deal board, one four inches square, the other six inches square. With the left hand hold the smaller piece close underneath the cotton; and with the sash tool or stencil brush work the meal paste *well into the fibers of the threads*, pressing the cotton on the board till it is thoroughly soaked, and rolling it over, laterally, to make it as round and smooth as possible. It is best to begin on the left and work towards the right. If the wetting slackens the threads, pull them tight. Now brush some meal powder through a fine sieve, to free it from lumps; put a tablespoonful or two upon the larger board; hold it close under the four threads, as the other, with the left hand, and move it laterally forwards and backwards, and down the whole length, at the same time brushing the meal over the threads with a soft, dry sash tool, till they are smothered, and giving them an occasional jar to shake off the superfluous meal. By a little practice they may be made as smooth and as round as a piece of wire. Leave the weight hanging to them till they are dry. Instead of four nails on each rail, a dozen may be put; and if the towel-horses are set 12 yards apart, 144 yards may soon be made. In this case, three or four heavier weights would be required. These contrivances, however, are by no means necessary for an amateur; four hooks or nails opposite four others, anyhow supported, will be sufficient; and six or eight feet apart is a good distance. A small quantity may thus be made one day, and a small quantity another; and for this purpose it is best to use gum-water, as it is always ready, and a little can be added to the dry left the day before, and a little fresh meal stirred in. Three or four threads of white darning cotton which is of two twists, make very good match; knitting or crochet cotton, which is of three twists, produces, alone, excellent match; two or three pieces of the first, or two of the latter, put into a leader pipe, side by side, blow through with a violent report. Match may also be made of the very narrowest white tape, three-sixteenths of an inch broad; this, from its flatness, is peculiarly suited for enveloped stars. For general purposes, however, lamp cotton is decidedly the best, as it is most loosely twisted, and therefore the most absorbent. If match is liable to be exposed to damp, it should be cased in thick leaders and be prepared with starch; in other respects nothing can surpass gum-water. Of course iron pound-weights, with a ring in them, will answer the purpose, or an iron pestle tied to the cotton, or anything heavy; but the kind I have advised are most convenient

They will weigh about a pound and a quarter each. The weight may hang over a chairback.

Match, to be perfect, ought, when cut across, to look black throughout; it should also be stiff, straight, and round; but, to test it, cut off about ten inches; put one end of this into a leader pipe, so that five inches will be in the pipe and five out. Hold the end of the leader with a pair of tongs or lay it on the ground; light the naked end. If the match is good it will burn gradually, though swiftly, till it gets to the pipe; it will then blow through with a bang. The nearer the leader pipe fits the match the better, only it ought to be large enough to allow it to go easily in, without force; if laid in a Roman candle case it would hardly puff; the smaller and smaller the tube becomes the louder and louder the report, the increase of power being in the inverse ratio of the diminution of space. A train of gunpowder laid in the open air, or confined in a tube, comports itself in the same way, as is well known. Match, when dry, should be kept straight; for, if it gets broken, it acts like a cracker, snapping at every break.

A piece of zinc rainwater pipe, of suitable length, furnished with a bottom and lid, or a couple of bungs, is convenient for keeping it in; but a far better contrivance is a deal box, five feet long, three inches deep, and three broad, made of half-inch pine. The lid of this box can be readily furnished with three or five hinges, like a piano, only made with string instead of brass. Take two pieces of string, Fig. 57, and tie them in a knot near the end, as at *k*. At *x*, Fig. 58, make a bradawl hole through the back of the box, near the top, and push the strings through it; make another hole through the lid, put the string through it, and tie in a knot on the top, as at *z*; and so with the other four. This will render the explanation easier to understand; but, practically, a single piece of thicker string is best, if you can manage to tie the second knot in the exact spot you wish. The knots must not be too close to each other, as the lid requires a little play. For safety, the box ought to be furnished with a lock.

PURPOSES OF MODERN MILLING.

THE task of the miller has always been defined as consisting in the purpose of taking from the inner parts of the grain the nutritious substances, and to prepare them so that they could, by the further process of baking, be brought into the most digestible condition for the human system. Recently, especially since the great chemist Liebig has unveiled the chemical procedure of nourishment, the miller's task has been enlarged, by the demand that he should also adapt to the use of man those nutritious portions of the berry which had supposedly until then been separated as component parts of the bran and used as feed for cattle.

Liebig, and those physiologists who concurred in his idea, had assumed that the stratum of gluten cells, which were separated with the bran, contained the most valuable nitrogenous matter, which, when brought into the flour, would be an excellent medium of nourishment for mankind. The millers, however, declaring that the technical devices then at their command did not enable a separation of the gluten stratum from the bran, Liebig and others advocated to rather let the whole of the bran and fibrous natter go into the bread, than to separate the supposed best and most nutritious matter together with the bran, and to deprive mankind in this manner of an immense amount of nutritive substances. In pursuance of this advice, bread was then largely made from unbolted flour or meal, and this was even introduced into hospitals and sick rooms.

Science, however, is progressive. Before long the theory of nourishment, brought to prominence by Liebig, was subjected to further investigation, and the supposed nutritive value of the bran was doubted. Experiments—mainly those of the French scientist, Poggiale—demonstrated that bran was indigestible. He fed dogs with bran and meat soup, then collected the "returns" from among the discharges, freed them from all foreign matter by the process of washing, then fed them a second time to a dog, and lastly to chickens. The result showed the bran to contain yet about one-third of its original percentage of nitrogen, after having successively passed through the digestive organs of those different creatures. Experiments by the German Professor Voit, in his laboratory of Munichen, demonstrated, subsequently, that the white grades of bread effected the smallest, and that the dark grades effected the greatest discharge from the intestines, wherein is to be found another proof of the indigestibilityof the outer portions of the grain, for the dark cast of flour is only due to the presence of branny substance therein. Other experiments were caused to be made by the French Emperor, Napoleon III., through the celebrated chemist, Mege-Mouries, who on this occasion found the *cerealine* to be one of the components of bran, particularly of the embryo-membrane inclosing the gluten stratum. This substance has the faculty of causing the formation of sugar from starchy matter, acting as a fermentum, causing discoloration and imparting a degree of acidity to the bread. These effects, however, can be prevented by forcing flour, which may contain bran and *cerealine*, into spirituous fermentation, previous to the baking, whereby the *cerealine* is decomposed and rendered harmless. Mege-Mouries from this discovery invented a peculiar process of bread-making, from flour containing bran, which is now largely in use in France.

However, such fine bread as the so-called Vienna article can never be made from such flour, on account of the presence of the *cerealine*.

At the present stage of science, moreover, the indigestibility of bran and the presence of *cerealine* therein do not form the only reasons why bran should be excluded from the food of man. Professor Schenk has demonstrated from analytical tests that *there is no gluten at all contained in the bran*, and this discovery has upset the entire theory, according to which the most nutritious portions of the grain were said to be wasted with the bran. If, however, any one may suppose that some other *digestible* nitrogeneous substance might be contained in the stratum of so-called gluten-cells, an experiment made by Professor Rathey, of Vienna, upon himself, may convince him of the contrary. This learned scientist writes about his experiment as follows:

"During Easter week I have, with exception of a little tea, taken absolutely no other nourishment than a sort of Graham bread, made from the very coarsest of wheat-meal, without any fermenting agencies and without salt. On the 5th and 7th days from the commencement of this diet, I examined my discharges and found the kernels, which had been but little affected by mastication, much softened, but almost wholly undigested, and so well preserved in their parts that the anatomy of the wheat-berry might have been easily established therefrom. The outer portions of the bran were totally, and *the stratum of gluten-cells almost equally, undigested.* Besides the undigested kernels of wheat, and particles of bran of different sizes, formed the major portion of the discharges. They proved to be the undigested remnants of the meal, of which the bread had been mostly made, the proportion of unbroken kernels having been comparatively small.

"Through an examination of these particles of bran I learned the interesting fact that they always contain the upper skin and the seedskin, and also the gluten-cells, and that the latter had passed in this form just as little digested as it had in the whole berry. Probably the very thick and indigestible membrane protects the contents of the gluten-cells against the action of the gastric juices.

"The circumstance that the whole or little broken kernels were undigested, is an evidence for the expediency of the reduction of the berry into flour, whilst the fact that the fragment of the gluten-stratum had also not been digested contradicts the very general assumption of the nutritive value of Graham bread."

The value of the bran for the purpose of feeding cattle may therefore be estimated as consisting chiefly in the starchy particles of the kernel, which to some extent will always be found with the bran, and in the germs, which may be mixed with it. It is also barely possible, that in case there should really exist some nitrogenous matter in the stratum of gluten-cells, this may be adapted for digestion by the stomachs of cattle, whilst the gastric juices of the human stomachs may not be sufficiently powerful to penetrate or dissolve the fibrous membrane inclosing the gluten-cells.

So we see that even if a system should be devised by which wheat or rye could be so decorticated as to take off the upper skin, this would by no means constitute any advantage. However, on account of the structure of the wheat-berry—notably the crease—it is hardly probable that a mechanical system of decortication should ever be accomplished.

A very interesting experiment was made by Professor Kick, for the purpose of ascertaining the percentage of those substances which should be separated from the flour. He soaked a number of wheat grains in water, then peeled off the skins and stratum of gluten-cells with the utmost care, took out the germs, and after drying, weighed the substances. They showed to represent 18 per cent. of the berry, thus leaving 82 per cent. of floury, starchy parts.

The germs contain undoubtedly many nutritious substances, but so much oily matter that they color the flour, and as the oil is apt to turn rancid, the flour is in danger of being similarly affected. In merchant milling, therefore, the germs should be taken out just as much as the bran. For the purpose of immediate baking and consumption, the germs might perhaps be put into the flour, although they would always be more suitable for feed.

If from the foregoing considerations we now wish to establish the purposes of modern milling, we can state them in the following words: "Milling should be directed in the simplest possible and most economical manner, to free the inner portions of the grain from the skin, the fuzz, and the germ, to crush the cells composing the kernel, and, by freeing the albuminous and starchy particles from the membrane inclosing them, to facilitate their direct and unobstructed communication with the gastric juice of the stomach and the other digestive organs."

The Austro-Hungarian process of high-grinding, with its most thorough separation of even the smallest branny particles, of all the methods existing comes nearest to this ideal, and the bread made from the Austro-Hungarian flour is, therefore, the most nutritious and most digestible of all the bread of the world.

If after these theories we now wish to answer the more practical question: "How much pure flour can be gotten out of grain?" we can give the figures obtained by Professor Kick's test:

	Pure flour.	Waste and feed.
Wheat, - -	78 to 82 per cent.	18 to 22 per cent.
Rye, - - - - -	75 to 80 per cent.	20 to 25 per cent.

—*Milling World.*

THE DE MERITENS ELECTRIC MACHINE.

ONE of the most interesting and remarkable machines for the induction of electric currents is the magneto-electric machine of M. de Meritens, which we illustrate on the present page. This apparatus is interesting because it embodies and

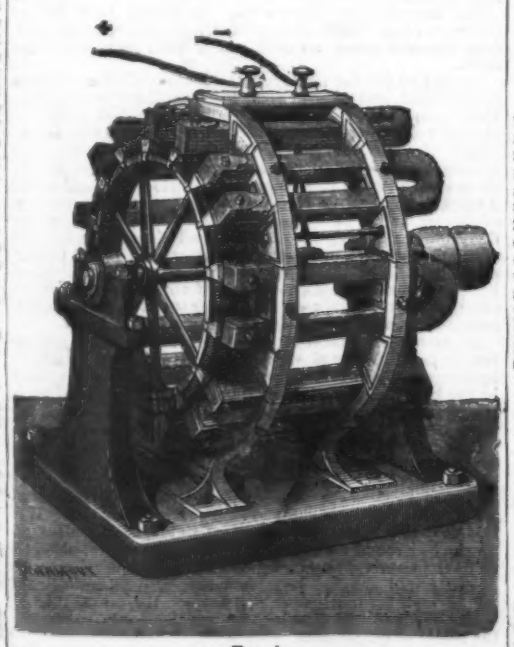


FIG. 4.

combines in its construction the principle of action of the early magneto-electric machines of Clarke and Holmes with that of the modern dynamo-electric machines of Gramme and Brush; and it is a remarkable machine on account of its very high efficiency as an apparatus for the conversion of motive power into electricity by induction from a magnetic field produced by permanent magnets, and on this account it stands alone among all magneto-electric machines as being able with some indications of success to hold its own for producing the electric light in a field which is otherwise monopolized by dynamo-electric generators.

The distinctive feature of the De Meritens machine lies in the construction of its rotating armature which, like the Gramme armature, is in the form of a ring, and wound in a similar way, but it differs from it in being made up of a number of segments, each constituting a separate arc-shaped electro-magnet with expanded poles, which are joined end to end with a thickness of insulating material between them, so as to form a continuous ring. It may for the sake of illustration be looked upon as a Gramme armature cut up into a number of short lengths and built up again into a ring, but each length being magnetically insulated from the other. This ring forms the periphery of a wheel, which is mounted

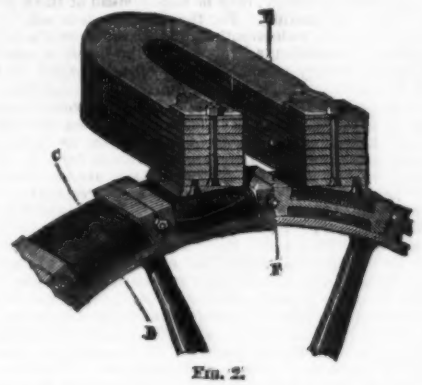


FIG. 2.

on a horizontal spindle, and is thereby rotated in a vertical plane within a crown of compound horseshoe permanent magnets, and just underneath their polar ends, the distances of which from one another are equal to the lengths of the armature segments, which is the same as the pitch of their poles around the ring; and the armature coils, although all wound in the same direction, are so connected up that while the current sent into the external circuit of the machine is alternating in direction, the currents generated in the several parts of the armature are at any one moment all of the same sign, and therefore in no way tend to neutralize one another.

In the machines as actually constructed, the magnetic crown or battery consists of eight horse-shoe compound permanent magnets, arranged as shown in Fig. 1, and of the construction figured in detail at E, Fig. 2. These magnets are rigidly attached to two circular frames of brass firmly bolted

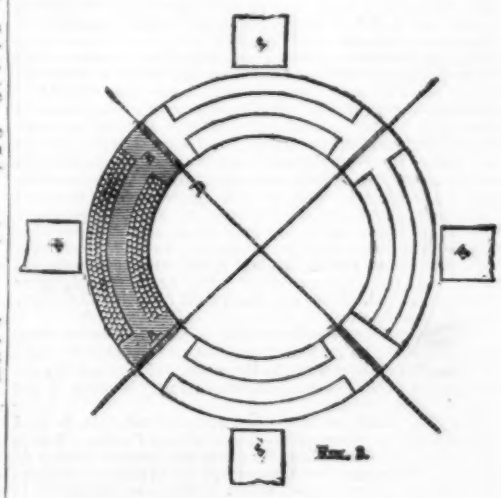


FIG. 3.

to the base-plate, and within the crown so formed the armature or induction wheel is caused to revolve on a horizontal spindle, and its electro-magnetic inductors are so arranged that their poles in their revolution pass in succession as close as possible to the magnet poles without actually touching them. The cores of the induction helices (see Fig. 2) do not consist of a solid mass of iron, but are composed of a large number of thin laminæ punched out of sheet iron one millimeter in thickness, and laid flat one upon the other, until a sufficient thickness is obtained. In the machine shown at the Albert Hall Exhibition there were as many as fifty plates or laminæ composing each segment of the armature ring. The advantages of this form of construction are twofold; first, the laminated character of the armature cores assists their rapid magnetization and demagnetization, break-

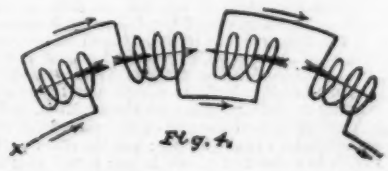


Fig. 4.

ing up and otherwise preventing cross currents by which their magnetic capacity is reduced; and second, the building up of the cores by means of superposed plates of the shape of its longitudinal section offers great facilities for construction. While each segment of the ring is thus built up the ring itself is, as we have before pointed out, also compound, as will be seen by reference to Fig. 2. The segments after having been wound with insulated wire are arranged end to end around a brass wheel, with strips of copper between them, so as to break up the magnetic continuity of the ring, making each segment a complete and separate magnetic inductor, and they are firmly held in their places and

together by a bolt passing through each joint, which is tightened up by a nut, as is shown on the diagram. The advantages of this method of construction are obvious to any one who can appreciate the slow and inconvenient process of winding a Gramme ring, which being a continuous circle can only be covered with wire by hand, the spool containing the wire to be wound having to be passed over and back through the ring for each convolution of the wire. By making the ring in segments, however, no such tediousness is experienced, for each piece can be put in a lathe and wound as an ordinary coil, and when so wound all can be joined up together with insulating pieces between them—a method of construction possessing especial advantages both electrically and constructively.

The action of the apparatus can best be understood by imagining an extremely simple case of a machine (illustrated in the diagram, Fig. 3), having an armature ring built up of only four segments, one of which is shown in section marked A B, and revolving within the magnetic field of two horse-shoe magnets, N S, N S, placed with their poles at equal distances around the ring, and so disposed that any point in the ring will during its revolution pass them in succession, assuming thereby alternately north and south polarity.

The expansion of the poles, A and B, so as to become flush with the exterior surface of the fully wound coil, besides facilitating the operation of winding, plays a still more important part, and it is to this that a great proportion of the high efficiency of the machine must be attributed. By this construction, which is also taken advantage of in the very beautiful dynamo-electric machine of Mr. Brush, the iron of the cores of the several segments of the ring is brought at its polar extremities into very close approximation to the inducing magnets, N S, in its passage beneath them, and it is for that reason in the best possible condition for being influenced in passing through their magnetic field.

The action of the machine illustrates, perhaps, more clearly than any other apparatus, the principle of that group of phenomena which is known as Lenz's law. Thus, supposing the armature to be rotating in the direction of the hands of a watch, the pole piece, A, approaching the north pole, N, of the permanent magnet, will cause an electric current to be induced in the coil, A B, in a certain direction, while the opposite pole piece, B, will, in receding from the same magnet pole, N, cause the induction of a current in the coil, A B, in the same direction as is produced by the approach of the pole piece, A; the two effects are, therefore, superposed or rather added together, and at the same time the current is still further increased by the convolutions of the coil of the same core passing from left to right through the magnetic field of the magnet, N. As the coils of all the segments are wound in the same direction, it follows that the next segment which passes below a south pole at the same moment as the segment, A B, is passing below a north pole, will have induced in its helix a current of electricity in the reverse direction to that developed in A B, which would be opposed to that current, and would, therefore, neutralize it, were it not for the fact that the successive coils are connected together in the manner shown in the diagram, Fig. 4, that is to say, the outside end of one helix is connected to the outside end of the coil which is in front of it, while its inside end is connected to the inside end of the coil which is behind it, from which construction it follows, as will be seen in the diagram, that although the currents induced in any two contiguous helices are opposite to one another in direction, the several helices are so connected together that the alternating currents transmitted into the external circuit by each of the coils are all at any one moment in the same direction; in other words, they are all, so to speak, either pulling or pushing together. The two ends of the entire circuit of all the electro-magnetic helices (which is not, as in the armatures of Gramme, Siemens, and Wallace-Farmer), closed within the machine, are connected respectively to two disk wheels of copper attached to the axis of the machine and revolving with it, but insulated from one another, and upon these wheels stout copper collectors or rubbers are maintained with a certain frictional pressure, and are connected to the two terminal screws of the machine. By this arrangement all commutators are dispensed with, and the construction of the apparatus is thereby much simplified. By variations in the method of coupling up the helices of the armature they may be connected in series, or more or less in parallel circuit, or may be grouped in combinations of the two, and by this means the character of the current generated by the machine may be determined for the work to which it is intended to be applied.

The inventor states, and his statement is backed up by the Comte du Moncel, that by this machine as many as three Jablochkoff candles can be maintained burning steadily with an expenditure of motive power of not more than one horse power, and without appreciably heating its armature or its coils when running at a speed of 700 revolutions per minute, but there does not appear to have been any photometric measurement taken by which the luminous intensity of the candles so illuminated may be compared with the light emitted by the same candles illuminated with the Jablochkoff system. M. de Meritens has, however, invented a candle of his own, which differs from the ordinary Jablochkoff bougie only in having a thinner carbon pencil placed between the other two, from which it is insulated in much the same way as in M. Jablochkoff's arrangement. The two outer carbons are connected to the machine, and the arc passes between them, the intermediate carbon acting merely as a bridge or stepping stone to enable the current to pass across under variations of strength. M. de Meritens claims for this form of construction the merit of greater steadiness of the light. It is, however, but fair to state that candles of this identical form were constructed and worked by M. Nysten several months before.—*Engineering.*

SCIENCE AT THE THEATRE.

IN connection with the play of "La Venus Noire," now being performed at the Théâtre du Châtelet, at Paris, a new feature has been inaugurated which seems to be quite a happy one. The successive scenes of the plot are developed in Africa, and the management has had the idea of collecting together in the saloon of the theatre objects, drawings, and photographs which represent in reality what the spectator apparently sees on the stage, and which permit him, between the acts, to cast his eyes on a truly interesting African exhibition. Instructive ideas are thus combined with the pleasures of the theatre—the *utile cum dulci*. We desire in this place to call attention to one of the most remarkable portions of this exhibition—to the beautiful photographs of the principal monuments of Egypt furnished by an amateur traveler and true artist, M. Henri Cammas. Some years ago M. Cammas and his wife left Paris, provided with all the apparatus necessary for the practice of photography, and proceeded to Alexandria. Here, the viceroy, approving of his enterprise, did all in his power to aid him in his projects, and gave him a beautiful bark—a *daabie*—which for nearly a year transported him up and down the Nile. It was on board of this comfortably arranged boat, provided with an interpreter and a firman given by the viceroy, that M. Cammas sailed through the valley of the Nile, everywhere taking the photographs concerning which we desire to give some details. The practice of photography in hot countries is surrounded with difficulties, especially where the production of large-sized negatives is concerned, like those obtained, by M. Cammas for instance. The dimensions of his—24 by 28 inches—have been surpassed in our own climate, where collodion is used and where there is everything to favor the operator; but no traveler to our knowledge has produced anything so remarkable as the photographs under consideration. M. Cammas used the Baldus process, in which glass negatives are replaced by albumenized paper negatives that are subsequently waxed. The use of distilled water, which is difficult to procure during a voyage, can be dispensed with, and the chemicals employed—nitrate of silver, acetic acid, and hyposulphite of soda—are such as undergo no change worth speaking of. The negatives are extremely portable, and for this reason M. Cammas has been enabled to bring back with him the whole of Egypt in a thin portfolio which required no particular care. He took eighty large negatives and more than a hundred smaller ones, representing the magnificent remains of the temples of ancient Egypt from Alexandria up to the third cataract. In the vestibule of the Théâtre du Châtelet may be seen some specimens of these photographs, one of which we reproduce herewith. It represents the ruins of the temple of Comombos, whose beautiful columns crown an elevated situation which was held sacred in ancient times. Comombos (anciently Ombos) was the capital of the last Egyptian "Nome;" and the province of the same nam a bordered on Nubia. The temple is remarkable for a large pylome suspended above the Nile; "this," says M. Cammas, "precedes a magnificent vestibule—a peristyle decorated with fifteen gigantic columns, the capitals of which support an imposing architrave. The walls and ceilings were covered with paintings which have resisted the sands and sun, but they readily peel off in large flakes. They were laid on a very hard and highly polished cement." Among the beautiful photographs exhibited at the Théâtre du Chatelet we should also call attention to those representing the island of Philæ and the temples of Ibsamboul, these localities being, with Thebes, the famous city of a hundred gates, the most marvelous sight in Egypt. The island of Philæ, which is about one-fifth of a mile long, is covered with the ruins of sacred monuments, proving that this enchanted abode was beloved of the gods as well as of mortals These ruins, which are, as regards age, relatively recent, are full of interesting souvenirs. The wonderful temples which cover its surface do not possess the gigantic size that characterized those of the early history of Egypt, but are better proportioned and more graceful. They mark the transition between two different architectures, and are the bond of union which unites Egyptian with Grecian art. Several extensive propylea are standing on this island, and chaplets of columns succeed each other in every direction. The variety of the capitals is remarkable, no two resembling each other. Unfortunately a large number of monuments are almost entirely destroyed. The temples of Ibsamboul are situated in Nubia, and count among the wonders of the Nile valley. The two temples are hollowed out of a single rock, and are excavated in the limestone strata of a mountain. At the entrance of the great temple four colossal figures are seated, their hands resting on their knees. Their height exceeds by 14 feet that of our highest five story houses. According to Champollion then are statues of Rhameses the Great or of Sesostris, who reigned in the sixteenth century before our era. The principal entrance is surmounted by a large cornice upon which are sculptured thirty-two gods, seen seated. Entering the temple, we reach a series of inner halls, the first of which is supported by eight pillars, and against these lean eight Rhameses, 28 feet in height. Behind this gallery the walls are covered with curious sculptures representing the conquests of Sesostris in Ethiopia. The interior of the two temples is covered with hieroglyphics and sculptures, but since the light of day does not penetrate therein, photographs can only be taken by the aid of incandescent magnesium or of the electric light.

WESTERN brewers meditate an advance in the price of lager beer, owing to the increased cost of hops and barley.

RUINS OF THE TEMPLE OF COMOMBOS, IN EGYPT.

SCIENCE APPLIED TO PRACTICE.

TECHNICAL education is day by day obtaining greater prominence, not only for the members of the engineering profession, but also extending to the army, navy, and almost every other profession, and even business. The question is often asked, *cui bono?* Are we any better, or are the members of the respective professions distinctly benefited by all this extra amount of mental training? There are many old-fashioned practical men who are much inclined to underrate the advantages of a scientific training compared with a practical one.

In our own profession, we would wish to bring before the notice of some of these would-be depreciators of scientific knowledge a few practical examples, occurring in our own experience, of the danger and disadvantage of a want of such knowledge.

The other day a wide heavy pulley was being delivered for fixture to a high-speed shaft running at 600 revolutions a minute. In consequence of careless handling, the pulley was cracked across the face in delivering from the cart. As the pulley was a tolerably expensive one, the mechanical firm supplying it decided to patch the pulley with a plate of wrought-iron inside, considering it thus to be equally as strong as it was before the accident.

This was true enough as to the circumferential strength of the rim; but the members of the firm in question, though essentially practical men, had no knowledge, scientifically or accurately, of the enormous centrifugal force developed by unbalanced weights rotating at such a high velocity as that they were dealing with. The patch and rivets unfortunately weighed about 15 pounds, as the pulley was a broad one. Had any of the practical men known the simple formula for

$$\text{Centrifugal force} = \frac{We^2}{ge} \text{ lb.},$$

where W is the weight of the unbalanced body in pounds, e is the velocity in feet per second, g is the acceleration of gravity—viz., approximately 32, and r is the radius in feet—they would have discovered the following startling result:

$$V = \frac{\text{circumf. of 3 ft. pulley} \times \text{revs. per minute.}}{60}$$

$$= \frac{3 \times 3{\cdot}1{,}416 \times 600 = 94{\cdot}248 \text{ ft. per sec.};}{60}$$

$g = 32$, and $e = 1\frac{1}{2}$ feet;

$$\frac{We^2}{ge} = \frac{15 \times 8{\cdot}882{\cdot}682{\cdot}68}{32 \times 1\frac{1}{2}} = 2{,}775{\cdot}8 \text{ lb.};$$

or, the outward radial force upon the rim of the pulley, generated by the unbalanced weight of 15 lb. running at a speed of 600 revolutions, amounted to very nearly one ton and a quarter!

From this scientific deduction the practical result is now obvious, the thin rim of a pulley, not more than a quarter of an inch in thickness, and cracked across, would be sure to break outward with such a strain. This was, in effect, the immediate result, so soon as the pulley commenced to run at anything like the normal speed. It was only owing to the peculiar position of the pulley, which worked underground in a covered trench, that the break-up of the pulley did not occasion loss of life or limb to the surrounding workmen. As it was, the pieces flew about like portions of an exploding shell, bending several portions of strong ironwork against which they struck, cutting the band, and knocking up the wooden covering of the trench.

On another occasion, a heavy bed-plate had to be lifted by a traveling crane and traveled up a workshop. As is the usual case in such circumstances, a chain was slung around the bed-plate, which was of considerable width, and the lifting-hook inserted under the center or bight of the slinging chain.

This is the usual method of slinging heavy weights, whether in workshops, or in ordinary factory lifting, and it is open to most dangerous liability to accident, unless discrimination is used in the method of slinging.

If a cord be attached to two pegs in a horizontal line, the slightest possible amount of pressure vertically in the center is capable of bending the cord from the horizontal line, thus making the point of pressure the meeting-point of three diverging forces, which are in equilibrium. Then, by the principle of the parallelogram of forces, the strain developed in the two portions of the bent horizontal cord are to the vertical force as the length of half the cord is to twice the perpendicular distance of the point of attachment from the horizontal line. And this proportion of strain in the cords can easily be three or four times that of the vertical strain, when the bending of the cord is not much from the horizontal. It will be seen that the strain becomes infinitely large on the horizontal cord when the latter is rigidly horizontal, and that this strain decreases as the cord is bent, so as to lessen the angle at the point of attachment, until it becomes *nil*, when the two halves of the cord become parallel.

Now these are the exact conditions affecting a sling rope as above described. In the case of the bed-plate, the length of the slinging-chain was somewhat scanty, so that, when fixed round the bed-plate, it was almost taut. If now the lifting-hook be inserted under the center of this slinging-chain, the latter can only bend a few inches from the horizontal line, and the strain thus produced on the slinging-chain is thus unexpectedly large. Let us take a few of the principal dimensions, and estimate this resulting strain.

The width of the bed-plate is 10 feet; the weight of the bed, 1 ton; and the lift of the slinging-chain, 3 inches.

The strain of the lifting-chain of 1 ton thus becomes—

$$\frac{5 \times 12}{6}$$

=10 tons on the slinging-chain.

As a rule, the slinging-chains are much slighter than the lifting-chain; because, if used judiciously, the strain may be much less on the former than on the latter. In the case in question, the increased and unlooked for strain was sufficient to break the sling-chain, dropping and breaking the bed-plate, and as nearly as possible to killing a workman who was standing by, who, however, luckily escaped with a scrape and a knock down.

Again, an air-compressing machine had to be designed to order, to give a certain amount or volume of air at a given pressure above the atmosphere. The machine was designed and built; when on trial it was found that the resulting volume of air was some 15 lb. lower in pressure than it was expected would be necessary to give the required volume; or, if the required pressure was obtained, the volume was too small. As all necessary and usual allowance had been made for leakage and waste, this result appeared somewhat unaccountable and disappointing. The opinion was formed that there was a blow-hole somewhere in the castings, or excessive leakage past the piston. A new piston was fitted, and a new air-cylinder cast, to insure freedom from blow-holes; but still the result remained the same. The calculations for the design were then called in question, and it was found that the calculation had been made on the following basis:

The capacity of the air-cylinder was 40 cubic feet.

By a compression of four times, the required pressure of 50 lb. would be obtained, with a volume of 10 cubic feet.

The proper percentage of loss and leakage had been duly deducted, but it had been entirely lost sight of, that the ultimate compressed volume of four atmospheres (60 lb.) was inclusive of the original atmospheric volume, and that therefore the resulting pressure would be only 45 lb. above atmosphere.

We could continue to enumerate a large number of similar examples where a want of a small amount of scientific knowledge has entailed serious loss and, in many cases danger to manufacturers and others. We think, however, sufficient has been shown, to demonstrate that there is some foundation for the present outcry for scientific education in the engineering and similar professions.—*Universal Engineer.*

THE UTILITY OF WATER FILTERS.

By "ISCA."

FROM time to time considerable stir is made in scientific and popular papers, and at sanitary meetings, as to the filtration of water intended for culinary and dietetic purposes, and the advisability or necessity of the universal adoption of house filters is strenuously insisted on by some persons, and as firmly denied by others. Imputations on the purity of the water supplied by the London companies, and by others in the country, are very easily uttered and believed by such of the public as are profoundly ignorant of the process by which it is cleansed before being sent into the street mains; while another section cannot bring themselves to think that the great expanses of sand and gravel, which they know are denominated filter beds, at large water works, can have much effect on the water which passes through them. The idea that sand is dirt, is probably fixed in the minds of many people, and they will not allow that any quantity of it can possibly have an equal effect to that of the neat looking apparatus which is fitted up with bits of sponge, blocks of carbon or spongy iron, or other patent material, for household use. At the late Social Science Congress, at Manchester, the utility of domestic filters was rudely challenged by several speakers, and there can be little doubt that the article referred to is too frequently regarded as a kind of conjuring apparatus which will go on yielding, to an indefinite extent, pure water for dirty, without receiving a tithe of the cleansing and attention which is bestowed on the rude sand beds of water works.

Remarks have not been wanting to the effect that water companies ought to adopt some means of filtration, other than the contemned sand and gravel beds, and this seems to have been a cry which has met with considerable favor at Hamburg, where a proposal has been made to adopt a system devised by Dr. Gerson, and stated by him to be applicable to primary as well as house filtration. The proposition appears to have attained such importance, that Mr. Grahn, of Essen, was led to make a thorough inquiry into it, and into the relative advantages of sand and gravel-filtration, and filtration by other materials, with especial reference to the chemical action claimed for some of the latter. His paper on the results of his inquiries was read at the meeting of the German Gas and Water Managers Association, held in June last, and recently printed in the *Journal für Gasbeleuchtung*, and contains matter of great interest, affecting both the health and pockets of consumers of water supplied by public corporations, who, terrified by the dismal pictures drawn by crotchet-mongers of the state of the towns water, frequently fall victims to sanitary quackery, and purchase costly filters, the best of which are really no more efficient than a common flower-pot filled with sand and gravel, while the worst are infinitely lower in the scale of utility.

Mr. Grahn says: At the end of last year Dr. Gerson published a pamphlet on the water supply of Hamburg, in which he condemned the proposal of the Town Council to establish sand filter beds. In place of these he recommended his own system, which, however, he did not advocate for Hamburg, on account of the dirty condition of the mains; but he advised the general use of house filters. It could scarcely happen that the water selected to supply a town would be such as to require house filtration in order to be wholesome. No public corporation would undertake the responsibility of cleaning and inspecting house filters; so that the control of the water as regards filtration will always remain with the town authorities, and be conducted in bulk. This is but right; the danger, however, lies in the fact that those who have the direction of these matters are generally untrained persons, and as such are apt to listen to mischievous proposals, the purport of which they are unable to understand.

Mr. Gerson's system is briefly as follows: The water first passes through a filter, in which it is freed from inorganic substances and bulky organic matters, and, if intended for dietetic purposes, then passing into a special apparatus calculated to remove organic impurities in the most complete manner possible. In the first filter are placed sponges prepared with iron solution and pumice stone; the second filter contains tightly packed Swedish iron ore, layers of sand of different degrees of fineness, or, instead of this, broken glass, and wool and pumice stone prepared with iron solution. Animal charcoal may also be used instead of pumice. This description is taken from the specification of the patent; other papers respecting the filters do not mention wool or animal charcoal, and name a certain kind of Swedish iron ore as a cheap substitute for Bischoff's spongy iron. The first filter is only to work under high pressure, and, therefore, in closed vessels; the second is to work in open vessels, and is then to be used in primary filtration, or in closed vessels under high pressure, for domestic filters. Thus there is nothing new in Dr. Gerson's list of materials, Spencer's magneto-proto-carbide of iron being similar to Swedish iron ore. The only novelty is in dividing the material into two receptacles. Some novelty is also to be found in the arrangement for cleaning the first filter. The lower sieve, which carries the sponges, is capable of being raised or lowered by means of a rod, which protrudes through a stuffing box, whereby the sponges can be squeezed out; and the sides of the second filter are lined with the same material which is used for filtration, in order to prevent any water passing through without coming in contact with the material.

When considering this description of filter with respect to primary filtration in bulk, the first thing to be settled is as to whether it fulfils the requirements of quantity and quality. According to the inventor, the first filter is able to purify in 24 hours from 500 to 600 cubic meters of water per square meter of surface, with a loss of head equal to one-fifth or one-fourth of atmospheric pressure. The action of the first filter is purely mechanical, and the pores of the material must, therefore, retain the eliminated dirt. The smaller they are the more efficiently this will be done, but they will then also be the sooner choked, and the filter will have to be the more often cleaned. According to Kümmel, the filter for the Elbe water, at Altona, has to be cleaned when 35 to 40 cubic meters of water have passed through every square meter of filter surface. If the Gerson filter be as effective for mechanical cleansing as the sand filter, its pores must be of the same size, and consequently it must be cleaned after having filtered an equal quantity of water. Supposing that a square meter of filter surface really filters 500 to 600 cubic meters of water per 24 hours, then the filter should be cleaned from 12 to 18 times every 24 hours; that is to say, once in every 1½ or 2 hours. For filtering in bulk 10,000 cubic meters daily, the inventor proposes twelve primary filters in two rows, each filter having a superficies of about two meters. Supposing five filters in each row to be in use, while the others are being cleaned, a filter would require cleaning every 16 or 24 minutes. It is probable that the sponges would soon lose their elasticity under this treatment, and therefore be subject to an alteration in volume, the effect of which would appear in the work done by them.

Any one acquainted with the nature of the dirt mechanically separated from water will know that it would be best cleaned off by a stream of that fluid. Hence it is evident that the proportion which the quantity of water necessary to clean the filter has to the quantity filtered by it is of great economic interest, as bearing on the net quantity of work done. The function of the pumice in these primary filters is not quite clear. It is intended to retain the dirt which passes through the sponges, and are the sponges thus to act as strainers for the pumice, or is it to act similarly to the gravel of the ordinary sand filter—*i. e.*, to prevent small pieces of sponge, etc., being washed away?

The secondary filters are intended to be contained in brick or iron tanks. Their superficies, however, is to be 30 to 35 times less, and the layers of material only half as thick as in sand filters. The filtration thus occupies from 1-30th to 1-35th of the time of sand filtration, and the water is only in contact with the material 1-60th or 1-70th of the time. In house filters, when the secondary arrangement is fixed on a high pressure service, the work is said to be performed in 1-200th of the time necessary with sand. In these secondary filters there is a quantity of sand or glass and pumice, which act mechanically, and a small portion only of the filtering material consists of iron ore, to which the chemical effect is to be ascribed. If the iron ore be 0·5 meter in thickness, and its granules be spheres of equal diameter, then the proportion of intermediate space to the entire area, independently of the diameter of the grains, is:

$$\frac{r^2\left(\sqrt{3} - \frac{\pi}{2}\right)}{r^2\sqrt{3}} = \frac{1732 - 1571}{1732} = \frac{161}{1732} = 0{\cdot}09$$

In every hour, by every superficial meter, 2·5 cubic meters of water have to be filtered, and the interstices amount to 0·09 square meter for every meter of filter surface; hence the water passes through a space of 0·5 meter in 1 min. 4·2 sec. Although this calculation makes no pretensions to great accuracy, it gives a good idea of the time during which the iron and water are in contact with each other. As this time is so short, and the substances to be acted upon are diffused very minutely through the water, a very strong chemical affinity between the two elements would be necessary, in order that the chemical process should go on throughout the whole. As the inventor considers the iron ore only in the light of a cheap substitute for Bischoff's spongy iron, it is only reasonable to suppose that the substitute is about as effective as the original, though certainly not more so.

Mr. Bischoff's spongy iron has been subjected to thorough examination from several points. Besides the exertions of the inventor himself, who has made his material the subject of much writing and public speaking, spongy iron was warmly recommended by Dr. Frankland in the Sixth Report of the Rivers Pollution Commission. Still, Dr. Frankland expressly states: "We wish it to be clearly understood that although this filtration of water polluted by excreta appears to provide a protection against epidemics, there is no reliable evidence, based on actual experiment, to confirm this opinion." Thus under all possible reserves! Later experiments upon spongy iron, by Dr. Lewin, of Munich, have given results differing widely from those of Dr. Frankland. Dr. Lewin requires a filtering material to possess the following qualities:

"It must absorb not only matter in suspension, but also substances physically and chemically latent, and must so retain them that additional impure or clean water cannot wash them out, or else they must only be carried on in a form which cannot influence the purity of the water. Of course it is essential that the material should retain these properties for some time without deteriorating." We may consent to the utility of these requirements, but at the same time we must own with Dr. Lewin, that such a style of filtration does not exist, either artificially or in nature. The ordinary sand filter is capable of mechanically retaining suspended matter by its capillary system, and of removing such dissolved impurities as are susceptible of mere surface attraction, and these intercepted matters are not liable to be washed out again, because when the capillary passages become filled with water, the further ingress of water is not possible. Thus we see that the filtering material must be fine enough to be filled up and the pressure on the filter must not thereby be so increased that the choked orifices become liable to be broken through.

Since the discovery of Figuier in 1811, another effect has been generally ascribed to charcoal, and especially animal charcoal. It has great power of absorption, but is also capable of saturation. The experiment of Edward Byrne (Institution of Civil Engineers, May 21, 1867) deserves mention. He filled a common earthenware filter with 5 lb. of newly burnt animal charcoal, such as is commonly in use in sugar refineries, and passed through it water containing 88·30 parts of inorganic, and 10·80 parts of organic matter. The first gallon filtered lost 52·60 parts of inorganic, and 4·80 parts of organic matter. This effect became less with succeeding trials.

The sixth gallon showed no loss in the proportion of organic matter, and the seventh and following gallons filtered showed a sensible increase of this kind of impurity, which increase amounted to 1·55 parts in the fifteenth gallon. Of the whole 13·48 parts of organic matter removed by the filter from the first six gallons, 4·98 parts were dissolved out by the following six gallons. At the twelfth gallon the loss of inorganic matter was only 8·8 parts, as against 52·60 parts in the beginning. It has further been proved, especially by the

experiments of Dr. De Chaumont, that a low organic life is speedily developed in water which has been filtered through charcoal, even when analyses taken immediately subsequent to filtration fail to show a trace of organic impurity; and that the same effect is produced in water by long contact with charcoal. Charcoal in small pieces produces the effect on the water by a contact of four minutes; large pieces take longer. Dr. J. Müller has even proved that spores of low organisms pass through compressed charcoal filters. The latest experiments with the charcoal filter commonly used in many parts of America, published by Professor Ripley Nichols, of Boston, Mass. (Tenth Report of the Massachusetts State Board of Health), have also proved its entire inefficiency. The water in these filters first passes through sponge and then through gravel and charcoal. The smallest of these filters weighs 150 lb., so that there is certainly enough material in them. The experiments have been repeated during many months, and no alteration has been discovered in the amount of organic impurity. When the sponge has been recently washed, a slight alteration in the water was observed; but it only lasted a very short time, and only affected the quantity of matter in suspension.

If charcoal can by no means be considered proper filtering material in cases where the operation is not subject to special control, iron, in its various forms, is certainly not more suitable, as Dr. Lewin's experiments have most clearly proved. According to Dr. Lewin, Medlock was one of the first who caused iron to be used for purifying water from organic matter. He proposed to suspend in the water to be treated bundles of iron wire of about 1·5 mm. diameter, 1 kilo of wire to 10 cubic meters of water. He imagined that the ammonia of the organic matter would, by oxidation, change into nitric acid, and that this acid would combine with the iron.

Now, the experiments of Dr. Calvert (*Comptes Rendus*, vol. lx., p. 453) have shown that metallic iron is not affected by water containing no gas, or in dry carbonic acid. The oxidation of iron requires the presence of oxygen or damp carbonic acid, both of which with iron create electrical currents, and thereby cause the decomposition of the water. In open water tanks, hydrated peroxide of iron is thus formed, without the removal of the oxygen of the organic substances present. According to Hofmann ("Water Supply of Leipsic," p. 32), this hydrated peroxide of iron will, in time, part with some of its oxygen to decaying substances, and change into soluble ferric-protoxide carbonate. Decaying matter and time are thus necessary for the due action of hydrated peroxide of iron. Lewin had dilute urine in contact with hydrated peroxide of iron for six days without any nitric acid being formed. The urine underwent the same changes as would have occurred had the iron been absent. He thinks the time required for organic substances to be acted upon by iron is so long "that families who might decide to wait until their foul water supply should be purified by iron would certainly perish for want of water."

Runze supposes that metallic iron absorbs the oxygen contained in water for its oxidation, and thereby producing water free from oxygen, preserves from decay organic substances present in it. It may be pointed out that the worst water from tanneries, etc., only contains traces of oxygen, that is most favorable for fungi. I will not consider the different explanations given by Spencer as to the action of his "magnetic carbide," or by Bischoff as to his "spongy iron," but examine the results of the experiments made by Lewin with one of Bischoff's filters, with a view to obtain practical evidence of its working. He filtered a fluid which contained a certain amount of nitrogen, and noted the loss of nitrogen by the filtrate, and then passed clean water through the filter, in order to ascertain the quantity of nitrogen taken up by it. During the first three days' experiment, 2 liters of urine, containing 16·325 grammes of nitrogen and 40 grammes of other impurity, were filtered, and the filtrate contained 4·2525 grammes of nitrogen and 10·615 grammes of refuse.

By pouring 7·5 liters of pure water into the filter, a fluid was obtained containing 15·816 grammes of nitrogen and 39·821 grammes of refuse; 0·508 gramme, or 3 per cent. of the nitrogen, was thus missing, also 0·179 gramme, or 4 per cent. of the refuse, which either remained in the filter or was lost. In a second experiment, which lasted four days, 4 liters of urine with 24·71 grammes of nitrogen and 48·5 grammes of refuse were filtered, and by afterwards passing 5 liters of water, 24·3018 grammes of nitrogen and 49·9 grammes of dry refuse were washed out.

The total amount of missing nitrogen was thus 0·41 gramme, or 1·6 per cent., and the residue had increased by 1·4 grammes, as the washing was done with water from the town mains. In the filtrates, neither nitrates, nitrites, nor ammonia were found. The result of an experiment with 80 cubic centimeters of glair in a glass tube, filled with spongy iron, was a loss of 2·7 per cent. of nitrogen. In order to further examine the action alleged by Bischoff to be exerted by spongy iron in decreasing the carbon of organic substances, Dr. Lewin filtered milk serum containing chloride of sodium, and on subsequent washing he found 2·9 per cent. of sugar and 0·1 per cent. of chloride of sodium missing. As the experiments lasted over three days, there is no room for the objection that there was not sufficient time for the spongy iron to act, especially as the quantity filtered was only 4 liters.

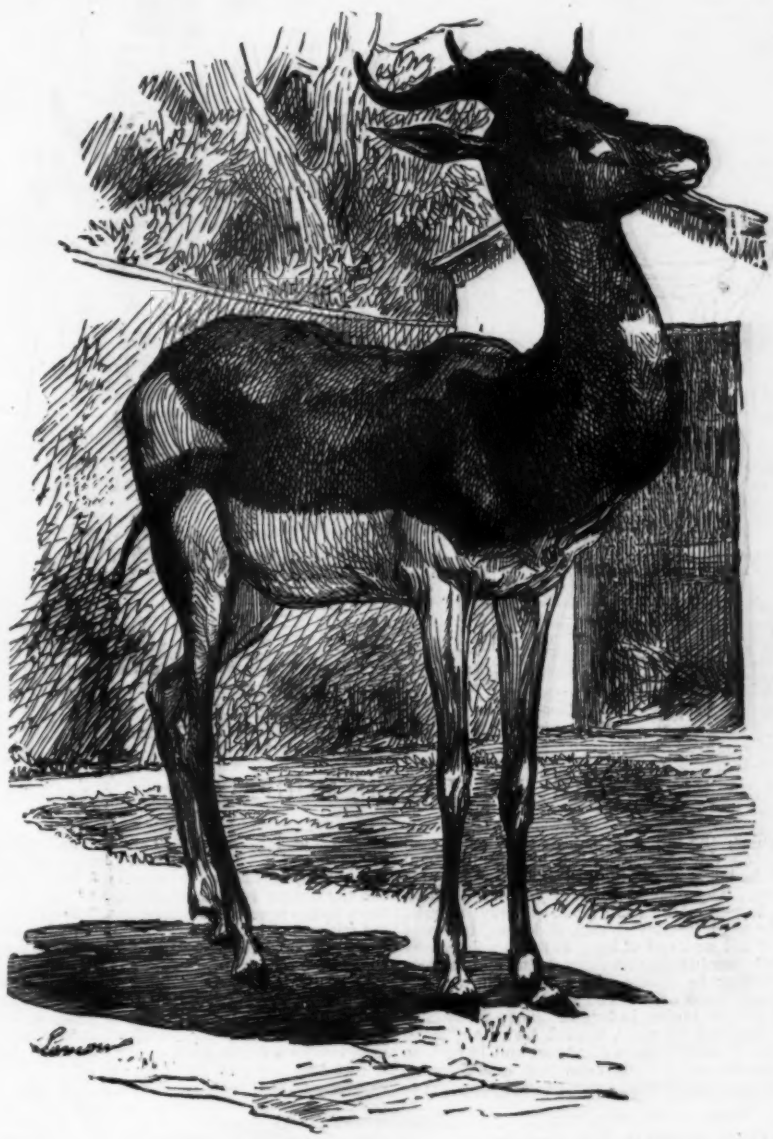
The conclusion drawn by Dr. Lewin from these experiments was that, in ordinary filtration, spongy iron has no chemical action on organic substances, containing nitrogen or otherwise, for the insignificant loss shown by the washings would probably be recovered with prolonged treatment, or it may be attributed to unavoidable error in estimation. Nicholls endeavors to explain the inertness of the spongy iron in these instances as due to the concentration of the fluids used. The reason for this is not very evident. From experiments made according to Dr. Frankland's and Professor Wanklyn's methods, he concludes that though the filtering material may have some effect on water not containing any considerable quantities of organic matter, yet the supply must be regulated, so as to allow the passage of only very small quantities in a fixed time, "so small, indeed, as to seriously interfere with the general use of the filters." The writer of the paper regretted that he had not been able to examine a Gerson's filter in the same way. As he himself, however, only considered his material in the light of a cheap substitute for spongy iron, Mr. Grahn had no doubt that similar experiments would have led to like results.

From experiments made with iron and silicated carbon filters by Mr. G. W. Wigner, who tested both kinds in combination, filtering through carbon first and then through iron, and *vice versa*, it appears that no change at all, or very little, is caused in the nitrogenous ingredients of water, by contact with either silicated carbon or iron, as used in domestic filtration, even when a minimum of water is treated —*i.e.*, when contact between the water and the filtering material is maintained as long as possible. Hence the amount of such chemical action when filters are in ordinary use may be imagined. The action, never present except at the commencement, soon ceases, and the material thenceforward acts only mechanically in removing suspended bodies, for which purpose there exist cheaper and more efficient materials. The case is similar with other materials considered valuable from their chemical action. Dr. Lewin says that it is only through the scarcity of published reliable experimental results, or popular ignorance of them, that it has been possible for inventors of filters to spread the most wonderful reports concerning the power of their wares. The public are kept informed only of such experiments as favor the inventors, who are also allowed to pass their own judgment on the purity of the filtered water. It is only too easy for these gentlemen to gain the public ear, especially by reason of the tendency of sanitary enthusiasts and guardians of the public health to continually dwell upon the injurious effect of organic matter in water, and, in spite of Pettenkofer and other investigators, never tire of ascribing typhus, cholera, and other horrors to such waters, and constantly spread the notion that closing wells will put an end to epidemics. Their pattern is Dr. Frankland, who always seeks to explain trifling changes in the mortality of London as due to small differences in the constituents of water as shown by his analyses; as, for instance, when he describes everything in water as so much dirt, and translates his quantities, for the sake of greater significance, into expressions of pounds of sewage in a cubic meter. His logical mind leads him also into other particular assertions, such as that a certain water would make every epidemic disease impossible.

In Germany there has been appointed by the Society of Public Health a commission, which was to ascertain "What are the dangerous impurities in water, and how they should be discovered?" The report has not appeared, first because of the illness of the reporter, and now, it is said, because the result would be negative. Although a true scientific standard in the discussion has not yet been agreed on, opposite sides have been taken by scientific men—Varrentrap, Reichard, Fischer, Wolfhügel on one side, and Pettenkofer, Sander, Nägeli, Wiebel, and Lewin on the other. No one would prefer dirty water to clean; every one would avoid water which is polluted, perhaps with excreta, even if there should be no direct proofs forthcoming of its dangerous character. If dirty-looking water must be used, it would be certainly filtered, if only for æsthetic reasons. But it is not right to condemn all water as unfit for use because it might require filtering to be made perfectly clear. As sand filtration has always led to satisfactory results wherever it has been skillfully planned and carefully looked after, and as no other equally efficient and practicable material exists, and as it must be owned, on close examination, that Gerson's method, and David's method likewise, are impracticable, it is difficult to understand why the people of Hamburg have not rejected Gerson's proposals. In the hope that similar trifling with important matters may not occur elsewhere, has Mr. Grahn's paper been written.—*Journal of Gas Lighting.*

THE BOUQUETIN.

THE animal represented in the accompanying engraving, the bouquetin, is a species of antelope, and is one of the recent acquisitions made by the Jardin des Plantes, of Paris. It is about the size of a he goat, and is a little more robust than a fallow deer. It is clothed with a very fine, soft coat of fur, intermingled with which are long and coarse hairs. The upper portion of the body is of a grayish fawn color, but underneath the color is whitish. The horns are large and black, bent backward in nearly a half circle, then forward again at the tips, and marked throughout nearly their whole length with very prominent rings. These creatures are inhabitants of high mountains, frequenting precipitous cliffs or rocky ledges. They are of a restless and timid disposition, exceedingly watchful, of great vivacity, and remarkably swift and agile; and their boundings are inconceivably light and elastic. They possess a most delicate sense of smell; their eyes are bright and beaming; and so fleet are they, and such wonderful leaps do they make from cliff to cliff, that even the greyhounds of the hunter find it difficult to overtake them. Their food consists of rhododendrons, the buds of stunted trees, such as the fir, willow, and birch, and such sparse and coarse grasses as grow at the limit of eternal snows.



THE BOUQUETIN, AT THE JARDIN DES PLANTES, PARIS.

DETECTION OF FUCHSINE IN RED WINE.—According to Fordos, a milligramme of fuchsine can be detected with certainty in a quart of wine, in a few minutes, by shaking about 2½ fluid drachms of the wine for several seconds in a test tube with 10 drops of ammonia, then adding 2¾ fluid drachms of chloroform and inverting the test-tube slowly, several times, taking care not to emulsify the chloroform, and thus render subsidence slower. On drawing off the chloroform, by means of a separating funnel, into a test-tube, and covering it with about ¼ of a fluid drachm of water, and saturating with excess of acetic acid, the regenerated fuchsine will impart to the water a more or less reddish tint.

NOVEL APPARATUS FOR THE MANUFACTURE OF MINERAL WATER.—Dr. Beins, of Groningen, has patented an apparatus for the manufacture of so-called mineral water, in which the carbonic acid employed is liberated from bicarbonate of soda by heating it. He has even succeeded in this way in producing the gas under such pressure as to liquefy it. Among the advantages of the process are the perfect purity of the gas, without any waste of it, and the absolute freedom of the water from any metallic impurities, whilst the residual carbonate of soda is readily disposed of. The usual machinery required for compressing, washing, etc., is dispensed with entirely, and economy of room and attendance is effected.

NON-CORROSIVE WRITING INK.—Ink made according to the following recipe, by Moschini, is said not to attack steel pens: Mix 10 grains of lactate of iron, 50 of powdered gum arabic, 20 of pulverized loaf sugar, and 6 of gallic acid in 1,000 of hot water.

THE HIMALAYAN MOUFFLON.

ONE of the most recent additions to the Jardin des Plantes, of Paris, is the animal figured herewith, a musimon or mouflon, from the Himalayas. The mouflon is intermediate between sheep and goats. It is placed by Bonaparte in the genus *capra*, on account of the absence of interdigital glandular openings, but has also been made the type of another genus—*caprois*—from its resemblance to a goat. It grows to about the size of a small fallow deer, and has very large horns. It inhabits steep, rocky places on the mountains of Corsica, Sardinia, the southern part of Spain, European Turkey, and the eastern Mediterranean islands, where, however, it is comparatively little known. The head is long, with compressed muzzle, swollen forehead, and large, erect, and sharp ears. The horns of the male are long and triangular, comprising more than half a circle, their bases occupying almost all the forehead, and separated only by a small space; they grow gradually smaller to the obtuse tip, with transverse wrinkles and raised rings. The body is

THE HIMALAYAN MOUFFLON.

large and muscular; the tail, with twelve vertebræ, turned down and bare on the underside. The legs are long and muscular, and the hoofs short; there is an appearance of a moderate dewlap. The general color is yellowish, with a chestnut tinge, deepest on the neck; head, ash-gray; muzzle, space about the eyes, interior of ears, abdomen, inside of thighs, edges of tail and end of legs, white; horns, ochery brown; the under wool is ashy or rusty white, and the hair is darker and thicker in winter. The females are without horns, or have very small ones. The average size is about 4 ft. in length and 32 inches in height. They are seen in flocks of one hundred or more, headed by an old male. They breed with domestic races of sheep, and have been themselves domesticated. It is from the mouflon and argali that our numerous domestic varieties are supposed to have sprung.

WATER SUPPLY FOR STOCK.

THE need for an ample supply of water for stock is paramount. The yard should be furnished with water constantly, in such a manner that the stock can always help themselves. A supply of running water from a spring or a well, raised in the latter case by means of a windmill, and carried in a pipe buried below the reach of frost, and discharged into a capacious trough, is the most convenient, and the cost is by no means disproportionate to the benefits gained by it. But great mistakes are made in the use of pipes, in consequence of neglecting the loss of carrying power resulting from friction, capillary attraction, and the adhesion of the metal; these, in many cases, completely overcoming the gravity of the water, and preventing any discharge from the lower end of the pipe.

Not long ago I was employed to examine the water supply of a large mansion and barns, which was found defective. I found 2,500 feet of half-inch pipe had been laid to carry the water from a spring to the barns, and up a hill having at least 150 feet elevation to the top of the house. The flow of water was totally inadequate, a stream of not more than an eighth of an inch in diameter falling into the cistern. The water was forced through the pipe by a small water wheel of about half of one horse power. The question submitted to me was why the water did not flow in a full stream, and what greater power could be applied to force a full half-inch stream through the pipe. The solution was not at all difficult. The loss of velocity from friction alone in the pipe was equivalent to a motion of 55·6 feet in a second, or a head of nearly 39 feet, leaving out of consideration altogether the elevation to be surmounted and the loss of velocity from adhesion or capillarity, and these completely neutralized the power of the water wheel. The fact is that a current of water with a head of 50 feet, passing through a half-inch pipe 1,200 feet long, will lose all its motive force by reason of the retarding influences referred to, and will merely escape from the outlet in single drops. And this will occur with the best made lead pipe, with a smooth inner surface. Rough iron pipe, of the same caliber, of a much less length, will not pass any water, and when encumbered with a deposit of rust, a larger pipe than half an inch will become useless.

The loss by friction in a one inch pipe, 1,200 feet long, is considerably less, being equivalent only to a loss of velocity of 8·9 feet in a second. So that in laying a pipe to convey water a long distance, the first part of it should be of larger diameter than the lower part; and if a certain amount of water is required, the size of the pipe should be proportioned not only to pass the required quantity, but to allow for all the losses caused by the retarding influences which have been mentioned; and further, the size must be still larger if the inner surface of the pipe is at all rough. The best and cheapest kind of pipe for the conveyance of water is wood. Iron will always communicate a disagreeable taste to the water; lead will in many cases be dissolved by the water, and the purer the water the greater will be the danger of injury by lead poisoning. Tin-lined lead pipe is not only costly, but unless the lining is perfect in every part the chemical action of the water upon the lead is more active, and the danger is actually increased. Hemlock scantling, three inches square, will make an excellent pipe when bored out with a 1⅛ inch auger. Hemlock, when always wet, is almost imperishable, and the timber gives no disagreeable flavor to the water.

To make these wooden pipes a frame of stout, rigid, but light timber may be made, similar to a long bench or double trestle. A piece of the 3 by 3 inch scantling is firmly fixed upon the bench by means of cleats and wedges. Two common trestles are then made to carry an auger, having a shaft 6 feet long and a crank at the end of it. The trestles are carefully leveled with the bench, and it would be well to connect the whole with strips fastened at each side to keep it steady. The trestles are provided with cleats 3 inches square, in which bearings are made for the auger shaft in line with the center of the scantling to be bored. The two bearings are carefully lined and leveled with the center of the bore to be made, and the auger is placed in them and is worked by the crank handle. When the pipe is bored half through, the scantling is reversed, and the hole is bored from the other end, the two bores meeting in the center. There will be less danger of the bore running out by proceeding in this way. The pipe is then finished by tapering off one end to a point, and enlarging the bore at the other end to receive this tapered point. A reamer is used to enlarge the bore; the edges of this tool are made sharp, so as to cut smoothly. Pipes of this kind, at the present price of lumber, will cost about one cent a foot, without the labor of boring them, which will be inconsiderable, even when the labor is hired. But those farmers having woodland, may select straight poles of spruce or hemlock of the size required, and use those in place of the scantling, taking care to remove the bark and to keep the pipes under cover until buried in the trenches, lest they may split in shrinking. Pipes of this kind may be made practically indestructible by laying them in a thin coating of hydraulic cement, or by coating them thoroughly with tar when laid. They will easily resist a pressure of 100 feet head, and if the timber is selected free from shakes and loose knots, they will not leak. The bore is such that there will be no difficulty in getting an inch of water at the outlet, with half a mile of pipe and with 50 feet head, or somewhat less with a head so low as 10 to 20 feet.—*Henry Stewart, in Country Gentleman.*

PRESERVATION OF APPLES.—All kinds of apples, it is said, can be preserved for a long time, without any loss of aroma, by packing them in layers, without touching each other, in sand that has been thoroughly heated, in quantities not too large, and previously allowed to cool. The boxes or casks should be closed as nearly airtight as possible.

PREPARING SOIL FOR STRAWBERRIES.

IN the garden, light soils can be given a much more stable and productive character by covering them with clay to the depth of one or two inches every fall. The winter's frosts and rains mix the two diverse soils, to their mutual benefit. Carting sand on clay is rarely remunerative; the reverse is decidedly so, and top-dressings of clay on light land are often more beneficial than equal amounts of manure.

As practically employed, I regard quick, stimulating manures, like guano, very injurious to light soils. I believe them to be the curse of the South. They are used "to make a crop," as it is termed; and they do make it for a few years, but to the utter impoverishment of the land.

And yet, by the aid of these stimulating commercial fertilizers, the poorest and thinnest soil can be made to produce fine strawberries, if sufficient moisture can be maintained. Just as a physician can rally an exhausted man to a condition in which he can take and be strengthened by food, so land, too poor and light to sprout a pea, can be stimulated into producing a meager green crop of some kind, which, plowed under, will enable the land to produce a second and heavier burden. This, in turn, placed in the soil, will begin to give a suggestion of fertility. Thus poor or exhausted soil can be made, by several years of successful management, to convalesce slowly into strength.

Coarse, gravelly soils are usually even worse. If we must grow our strawberries on them, give the same general treatment that I have just suggested.

On some peat soils the strawberry thrives abundantly: on others it burns and dwindles. With such a soil, I should experiment with bone dust, ashes, etc., until I found just what was lacking.

No written directions can take the place of common sense, judgment, and, above all, experience. Soils vary like individual character. I have yet to learn of a system of rules that will teach us how to deal with every man we meet. It is ever wise, however, to deal justly and liberally. He that expects much from his land must give it much.

I have dwelt at length on the preparation and enrichment of the land, since it is the corner stone of all subsequent success. Let me close by emphasizing again the principle which was made prominent at first. Though we give our strawberry plants everything else they need, our crop of fruit will still be good or bad in proportion as we are able to maintain abundant moisture during the blossoming and fruiting season. If provision can be made for irrigation, it may increase the yield tenfold.—*E. P. Roe, in Scribner's Magazine.*

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